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THE EIRA ARCTIC EXPEDITION.

It will be remembered that Mr B. Leigh Smith, in following up his previous year's discoveries in Franz Josef Land, sailed from Peterhead in his private ship, Eira, on June 14, 1881. Nova Zembla was sighted on the 30th, and after many attempts an opening was found in the ice in lat. 73° 33' N., and long. 46° 8' E., on July 13, and the Eira steamed north, reaching Franz Josef Land on the 23d of July in the same summer.

Some days were spent in Gray Bay shooting walrus and bears. As the ice was close down on the west coast the Eira tried to go up Nightingale Sound, but this being also closed with fast ice she returned to Bell Island, and put up a store house. On the 16th of August the Eira steamed toward Barent's Hook, with the intention of going east to look for the Jeannette, but found it impossible to pass, and some days were also spent near Cape Flora in dredging, and collecting fossils and plants.

On Sunday morning, August 21, the pack came in, and the Eira was caught between it and the land floe. It is supposed that a tongue of ice went through her side, near the fore-rigging; she filled rapidly, and sank before many stores were saved. As she went, the men cried out, "She's awa'!" "She was our home!" "She was a bonnie ship!"

Notwithstanding every exertion, the crew of twenty-five men had barely two hours to save such provisions as were nearest at hand before the ship went down, leaving them homeless on the ice. They had, however, succeeded in cutting some sails from aloft, and had saved their boats, and about three hundredweight of bread, a few barrels of flour, some preserved vegetables, tea, sugar, tobacco, and spirits, and such bedding and clothing as could be hurriedly thrown out upon the ice. A temporary tent was erected upon the floe ice from the sails saved, and under this shelter the crew passed their first night.

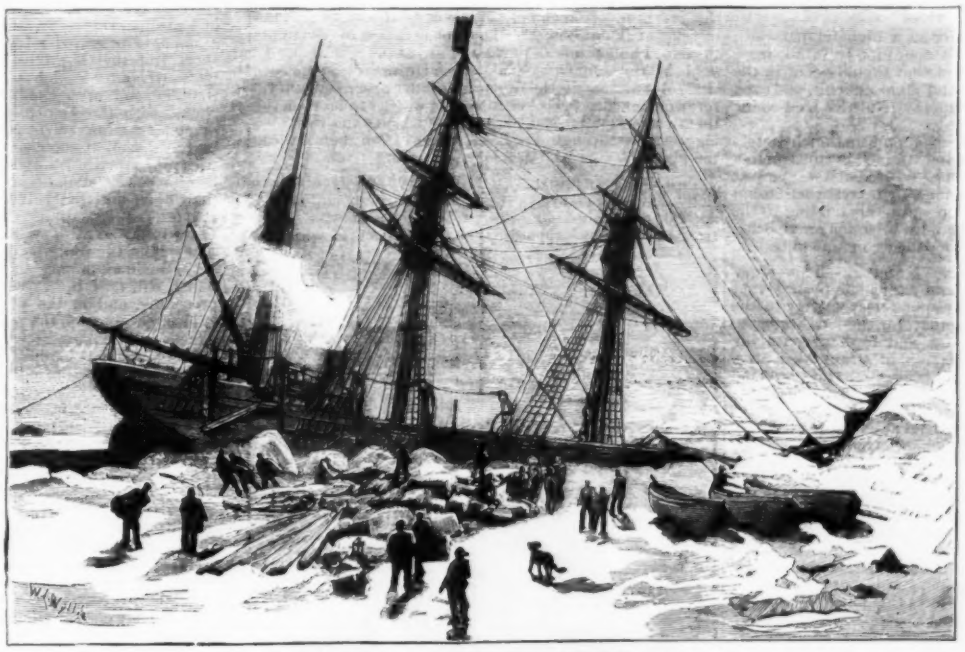
Next day they moved to the land at Cape Flora, and there put up the tent; and having dragged the boats and stores to the shore, they proceeded to build a house of loose stones and turf, as all hope of escaping from Franz Josef Land in that year had to be abandoned. The explorers had to look forward to passing a long and dreary winter in such shelter as the hut could afford, and to depend upon their own exertions for such food as could be obtained. The house was 38 feet long by 12 feet broad, and covered with the ship's sails.

As winter approached, it was almost buried beneath a snow drift. A large oil lamp, after the custom of the Esquimaux, was prepared, and the oil from the game killed was used in it for the purpose of cooking their food. Warm clothing was made out of some strong cloth saved, and winter boots were made with canvas tops, and the soles of twisted rope-yarn.

Fortunately the firearms and ammunition had been saved, and every effort was made to lay in a stock of birds before they migrated southward.

During the early winter bears were numerous, and often came to the hut, prowling around the door, and even on the roof; and walrus were frequently found at the edge of the fast ice whenever the pack had moved off by the force of the wind, and had left some water spaces.

A faithful companion in their misfortunes accompanied the explorers in the shape of a retriever dog, and this useful animal was of the greatest service to them during the long winter nights, in leading the bears up to the house, and within range of the rifles; and also in discovering the walrus lying upon the ice, and bringing the hunters up to them. Some books had also been saved from the ship, and added much to the explorers' comfort during the long hours.



SINKING OF THE ARCTIC STEAMER EIRA.

The winter was passed without any serious effect upon the health of the men; and, although in March their provisions became very scarce from the absence of animal life, at the end of that month bears again appeared, and at the latter part of the following month the birds began to fly northward, and the explorers were enabled to provide themselves again with fresh food.

As the summer advanced, preparations were commenced to attempt the escape in the boats. Sails and tents were made from the old canvas and table-cloths, and some walrus meat was put in tins for the journey. Stores were provided sufficient to last for two months, and on June 21, 1882, all being ready, and a large expanse of water having appeared to the south, the boats were dragged to the edge of the land floe and launched. They sailed away southwards for some eighty miles without meeting any ice of consequence, a strong north-west wind having blown the pack thus far away. Soon, however, the pack ice was met with, and the boats were beset, and further progress stopped.

On the 1st of July the ice opened out, and some advance was made by forcing the boats through narrow leads, dragging them over necks of ice, and sailing or rowing through pools. This work continued day after day, the boats being often much squeezed by the ice. When no progress could be made the boats were hauled up on a floe, the tents put up over them, and all rested until the ice opened out again. At last, on August 1st, the open sea was reached, and the boats sailed east with a south-west breeze, which increased to a gale, and then a thunderstorm. After twenty-four hours the boats reached Nova Zembla, and were drawn up on the beach at the entrance to Matotchkin Straits on the evening of August 2. Sailing into a small bay, the explorers observed a cairn and staff on a point of land, just behind which the Hope and the Willem Barents were anchored at the time.

WINTER QUARTERS OF THE SURVIVORS OF THE EIRA ARCTIC EXPEDITION.

But in consequence of a heavy fog coming over at that moment, they ran the boats on the nearest beach, and camped for the night, within half a mile of the cairn and staff. At the cairn, which indicated the position of the Hope's anchorage, Sir Allen Young had deposited a letter for Mr. Leigh Smith, and here Sir Allen was just about to land a depot of fourteen days' provision for the Eira's crew. Mr. Leigh Smith intended to examine the cairn as soon as his men had rested and the fog cleared off, and in that case would have almost looked down on board the Hope. However, on the following morning all anxiety was set at rest by the discovery of the two ships, the Willem Barents being off the point, she having just ten minutes previously parted company with the Hope to proceed northward.

A boat was launched from Mr. Leigh Smith's camp, and the Hope's boats were at once sent away on shore, when, to the intense relief of everybody, the Eira's crew was soon brought safely alongside, and Sir Allen Young, his officers, and crew had the pleasure of welcoming them on board. Every attention was paid to the comfort of the travelers, and they were told off to their different berths according to their rating with the Hope's crew. The Kara was also in the straits, and Mr. Leigh Smith's old friend, Sir H. Gore Booth, had also the gratification of shaking him by the hand on board the Hope.

As the objects for which the Hope had been dispatched from England were now so successfully accomplished, and as there were no further reasons for remaining on the desolate shores of Nova Zembla, the ship's fresh-water tanks were refilled, the stores were restowed, and her own and Mr. Leigh Smith's boats hoisted up. She set sail for England on the 6th of August, arriving at Aberdeen on the morning of the 20th, when Sir Allen Young immediately made arrangements to forward the Eira's crew to their homes, where they all arrived the same afternoon, after their long absence and perilous voyage.

Mr. B. Leigh Smith was born the 12th of March, 1828. He was educated at Jesus College, Cambridge, and was a wrangler in 1852. Later he became a member of the Inner Temple, and was called to the Bar but never practiced. Mr. Leigh Smith has long had a passion for Arctic enterprise, and in the years 1871, 1872, and 1873 he made voyages to Spitzbergen in hired vessels. In the summer of 1880 he penetrated almost as far as Franz Josef Land, discovered by the Austrians some time before. This voyage was undertaken in the Eira, a vessel specially built for the purpose by Mr. Smith, and though little was known to the public of the expedition, its results were considered so important as to warrant the bestowal upon Mr. Smith of the medal of the Royal Geographical Society. In the recent expedition the Eira was victualed for two years only.—*London Graphic.*

[In our SUPPLEMENT, No. 320, will be found a view of Eira Harbor, Franz Josef Land, and further particulars of the Eira Expedition. In the same number, also in SUPPLEMENT No. 339, will be found engravings of the Arctic steamer Jeannette, portrait of Captain De Long, with an account of the loss of the vessel and many of the brave men that composed her crew.]

ON FEED-WATER INJECTORS OF VARIOUS SYSTEMS.

THE apparatus that we shall examine in this article are all based on the principle employed by Giffard in the construction of his injector, this principle being the lateral communication of the motion of fluids. A pipe issuing from the boiler terminates in a cone-shaped part, through which the steam escapes; and the extremity of this cone ends near the bottom of a space into which the feed-water is sucked. In the axis of the cone, the bottom of the space carries a slightly divergent neck, which is prolonged by a pipe communicating with the boiler. The steam, as a consequence of its condensation by contact with cold water, comes in with great velocity, and consequently possesses a live power sufficient to cause not only the water proceeding from its condensation to enter the boiler, but also that which has served to condense it; and this is sufficient for feeding the boiler.

If we examine the modifications and improvements introduced into the Giffard injector, we shall find that they bear on three principal points:

1. Simplification of the mechanism, and strength in construction, so as to afford as few chances as possible of getting out of order.

2. Reduction in the number of maneuvers to be effected, so as to put the apparatus in operation as promptly as possible.

3. Method of feeding with water at a high temperature; a very desirable, but very difficult condition to fulfill, inasmuch as the condensation of steam that should occur in the injector becomes naturally more and more difficult, and even impossible, in measure as the temperature of the feed-water rises.

We shall study also several types of non-suction injectors that permit of great simplicity being attained in construction and maneuver; and we have likewise represented a type that differs from Giffard's and the rest, not only in construction, but also in the principle on which it operates, this relating to the use of waste steam from the engine for injection, and being consequently applicable to non-condensing motors only.

THE GRESHAM INJECTOR (Figs. 1 and 2).—This apparatus consists of two parts, A and A', which possess four necks, B, C, D, and E, that correspond respectively to the pipe for the ingress of steam, to that for the feed-water, to that for the escape of waste-water, and to that for forcing water into the boiler. The injection of steam takes place through the conical nozzle, F, and is effected and regulated through a valve, *a*, and a conical valve, *b*, both belonging to a rod, G. This latter is provided with a thread that works in a nut in the cylinder, A', and carries at its upper extremity a hand-wheel, *c*, by means of which, first, passage may be given to the steam by raising the valve, *a*, and next, on continuing to turn it, the quantity of steam may be regulated by raising the needle, *b*. Beneath the nozzle, F, there is a socket, H, which has in its interior two converging and diverging cones, I and J, at whose point of junction there is a small aperture, *d*. Through this latter escapes the small quantity of water which, when the injector is primed, cannot force an entrance to the boiler, but is stored up in the space that the cylinder, A, presents at this place, and finally escapes through the pipe, D. When the apparatus is primed, and the current of water and steam has reached a velocity sufficient to overcome the pressure of the boiler, this water can pass from the nozzle I to J, and, detaching from its seat the stop-valve, K, finally reach the generator. The socket, H, that carries the cones, I and J, is movable, and slides with slight friction in the cylinder, A, and, by the different heights that it occupies, regulates the passage of the water between the nozzle, F, and the converging cone, I. For this purpose it carries, as may be seen, a rack that engages with the pinion, *e*, whose axle carries a hand-wheel, *f*. Datum points marked on the circumference of the latter, in connection with a stationary index on the body of the injector, permit of ascertaining at any moment the position of the socket, I, and of regulating with certainty the quantity of water that is given passage to.

BOUVRET'S INJECTOR (Figs. 3 and 4. One-fifth actual size).—This apparatus presents as an interesting peculiarity the simultaneous regulation of the introduction of water and steam, this being effected by a single maneuver. The parts are designated by the same letters as in the preceding apparatus. We shall confine ourselves to the parts that realize the principal object sought. By reference to the figures, it will be seen that the rod, G, that carries the handwheel, *c*, is connected at its other extremity through a strong screw, with a tube, *a*, of small diameter, and with a socket, F, surrounding the latter. This tube is conical at its extremity and revolves through its thread, in a bronze nut, F^1, whose collar is held between the flanges of the parts, A and A', composing the body of the injector. This central tube communicates, through apertures, *a'*, with the steam coming from the boiler; and the socket, F, is provided with a valve, *b*, which, when the apparatus is at rest, closes the annular passage around the socket's extremity, that is likewise in communication with the steam. When the valve is removed from its seat the apertures, b^1, permit the steam traversing it to enter the interior of the socket, F.

To set the apparatus in operation, the cock, B, is first opened so as to allow the steam to enter through the apertures, *a'*, into the tube, *a*, which ends in a nozzle of very small diameter. An escape of steam then occurs with very great velocity, and carries along the air contained in the suction-pipe, C, and the water rises therein and flows through the waste-pipe, D. It is then only that the handwheel, *c*, is turned, when the valve, *b*, gives passage to the steam, and this, entering the tuyere-socket, F, through the holes, *b'*, finally forces water to the boiler. The hand wheel is then turned still more until the water stops running out through the waste-pipe. The current is then established, and the quantity of water passing between the conical extremity of the socket, F, and tuyere, I, is regulated with certainty. This injector may also be constructed so as to be mounted vertically.

THE BOHLER and GUYENET INJECTOR (Figs. 5 to 8. One-fifth actual size).—The maneuvering of this apparatus presents some analogy with that of the preceding. The rod, G, which is conical at its extremity, and regulates the aperture of the injection nozzle, F, also has a valve, *a*, and is perforated with a longitudinal aperture, *b*, that connects, through the transverse one, *b'*, with the steam inlet. As soon as the admission valve is opened, the steam enters through the pipe, B, flows through the apertures, *b'*, *b*, and drives out the air contained in the apparatus, and in the suction-pipe, C. When the water has risen and begins to flow through the waste-pipe, D, the handwheel, *c*, is turned in the proper direction to remove the valve, *a*, from its seat, and to regulate the passage of steam between the conical extremity of the rod, G, and the interior of the nozzle, F. It will be remarked that the tuyere, I, is completely surrounded by the water sucked up, and the latter enters it only through the holes, I'. The object of this arrangement is to prevent its being raised to too high a temperature, since the latter would render the condensation of steam more difficult, and prevent the apparatus from working regularly.

Figs. 6 and 7 show sections of an injector devised by the same constructors for operating with water under pressure. As there is no suction to be performed here, the rôle of the steam is limited to giving the inflowing water sufficient pressure and velocity to send it into the boiler. Apparatus of this nature are characterized by great simplicity. The water enters the chamber, A, of the injector through the cock C (cast in the same piece), surrounds the tuyere, I, and enters it through the apertures, I'. The injection of steam is effected through the double cone, F. To start the apparatus, the water admission-valve, C, is turned on all the way; the cock that sends the steam from the boiler to the injector through the pipe, B, is turned on slowly and by degrees; and the cock, C, is closed until water ceases to flow in excess through the waste pipe, D.

THE SCHAEFFER and BUDENBERG INJECTOR (Fig. 9).—In this apparatus, as in the preceding, the injection of steam takes place, first, through a central channel, *b' b*, in the conical extremity (forming a valve) of the rod, G, and then, when this rod is revolved sufficiently, around the valve and in the interior of the nozzle, F. The construction of the opposed tuyeres, I and J, merits particular attention. Without being held in the same piece, as in the Gresham injector, or entirely distinct, as in the other apparatus described, they are screwed one into the other in such a way as to leave between them a small cylindrical cavity, from whence the waste-water may escape through the holes, G, and from thence through the pipe, D.

THE CUAU INJECTOR (Fig. 10).—This apparatus is essentially distinguished from the preceding by the addition of a special part called an *ejector*, which is somewhat distinct from the principal apparatus, and the object of which is to

MR. LEIGH SMITH, COMMANDER OF THE EIRA ARCTIC EXPEDITION.

suck up water at the starting of the injector. It will also be remarked that the needle, or conical valve, for regulating the injection is here entirely dispensed with. By reference to the figure, it will be seen that the steam enters through a two-way cock, B, by means of which it is directed, first, through the tube, *i*, against the ejector, M. This latter, which is fixed on the waste-pipe, D, has for its essential part a nozzle, M^1, through which the steam rushes and carries along the air contained in the apparatus. When the sucked-up water passing through the cock, C, has introduced itself into the injector, and is flowing through the purge pipe, i^1, the key of the cock, B, is slowly reversed so as to direct the steam upon the nozzle, F, of the injector properly so-called. The water is then forced to the boiler through the tuyeres, I and J, whose structure is analogous to that of those in the preceding apparatus.

THE "UNIVERSAL INJECTOR," ON THE KOERTING SYSTEM (Figs. 11 to 16. One-fifth actual size).—Here we have a kind of injector differing essentially in external structure from the different apparatus just noticed, and whose principle consists in the use of two nearly similar injectors that are designed respectively for suction and forcing. Owing to the special and peculiarly interesting arrangements that this apparatus presents, we have devoted considerable space to it in the plate, and shall study it in some detail. Fig. 11 shows it in elevation, the controlling mechanism being turned toward the observer. Fig. 12 is a vertical section, in which the apparatus is supposed to have made a half revolution so as to bring the controlling mechanism in the rear. Fig. 13 partially reproduces the same section, but in a position of rest. Figs. 14 and 16 are three horizontal sections according to the lines 1-2, 3-4, and 5-6 respectively. As may be seen, the chamber of the apparatus consists of a cast-iron vessel, A, of elliptical section, cast in a piece with the necks, C, D, and E, which correspond respectively to the pipe for ingress of water, to that for the escape of priming water, and to the force-pipe. The chamber, A, is surmounted by a dome-shaped piece, B, through which enters the steam with which it is constantly in communication. In this piece there are placed two valves, *a* and *b*, which allow the steam to flow through the nozzles, F and G, that connect with the convergent and divergent cones, I and J. As may be seen, these two cones, I and J, debouch at their upper extremity above a horizontal partition, *c*, to which is joined the vertical and cylindrical partition, c^1, that isolates I from J, and puts it alone in connection with the suction pipe, C. The partition, *c*, does not occupy the entire section of the chamber, A (which, by the way, is dilated at this point), but leaves two wide passages which form the debouching point of two channels, K, that project from the chamber, A (Figs. 11 and 16), and the entrance of one of which is seen in Fig. 12 under the partition, *c*. It is through these channels and the empty spaces left by the partition, *c*, that the water filling the chamber, A, around the suction cone, I, rises into the upper part of the apparatus, and flows to the force cone, J.

The cock, L, on the pipe, D, is only open during the starting of the injector in order to allow of the escape of the air contained in the apparatus, and of the small quantity of water forced in the beginning—neither of these having as yet a velocity and pressure sufficient to force the stop-valve, M, from its seat, and thus allow the steam to enter. When the apparatus has once begun to run regularly, this cock, L, is closed so as to prevent air from entering the injector.

These different phases in the setting of the apparatus in operation are effected very rapidly, and simultaneously by a single maneuver on the part of the engineman, as we shall now show.

The valves, *a* and *b*, are maneuvered successively—the suction valve, *a*, first (at closing as well as at the opening), since the water naturally has to flow to the injector before being driven from it, and forcing having to occur last in order to send to the boiler the greatest part possible of the water that still fills the chamber, A, while the suction is closed. Such result is obtained very ingeniously by the aid of a mechanism shown in Fig. 11 to 14. Each of the valves, *a* and *b*, is provided with a stem, which is prolonged by a short rod that is guided by a cylindrical aperture in the piece, B; and on each of the stems there works freely the rounded end of a small lever that pivots on a pin, *f*, connected with the axle, *g*, of the hand-lever, N. The result of such an arrangement is that when the lever, N, is reversed in the direction shown by the arrow in Fig. 13, the eccentric pin, *f*, will rise and move toward the right with the lever, *e*. The stem, *d*, is then submitted to a shorter lever than *d'* is; and the valve, *a*, which is smaller than *b*, and also offers less resistance than it does, will rise first and continue to do so till *d* abuts against the sides of the aperture that guides the rod, d^2. From this moment this valve-stem will remain stationary and serve as a support to the lever, *e*, which will raise the valve, *b*, until its stem, d^3, stops like the preceding, and in the position shown in Fig. 12. When it is desired to stop the working of the apparatus the same effects will be reproduced.

To render the maneuver of the starting cock, L, automatic and connected with that of the valves, the hand-lever, N, is cast in a piece with an arm, *h*, which is connected by a rod, *h'*, with the lever, *i*, mounted on the plug of the cock. It is then through the movement of this lever solely that the injector is started or stopped. It works as follows: The injector being at rest, that is, the valves, *a* and *b*, being closed and the cock, L, open, the lever, N, is slowly drawn as far as it will go in the direction of the arrow (Fig. 11). During this single motion all the phases of starting the apparatus are accomplished. The valve, *a*, is raised; the steam drives out the air and sucks up the water which partially flows through the cock, L, that is beginning to close; the valve, *b*, opens in its turn and forces the water furnished it by cone, I, into cone, J; the current is set up; the cock, L, closes entirely; and the water, overcoming the resistance of the valve, M, forces an entrance into the boiler.

We have said that the two injectors, F I and G J, presented some difference in structure: in that for suction, the cone, I, is of larger diameter than J; in that for forcing, in which the water must assume its maximum velocity. The valve, *b*, of the force injector has an appendage, b^1, that forms a sort of needle, and determines exactly the passage and direction left to the steam.

THE DIXON INJECTOR (Figs. 17 to 20. One-fifth actual size).—The apparatus that now remain to be described are essentially arranged to receive water under pressure of gravity, and three of them have been designed in view of prospective application to locomotives.

The Dixon injector is arranged for supplying a stationary engine, or, with a few modifications, a locomotive boiler. Fig. 17 gives a longitudinal section of it; Figs. 18 and 19 are transverse sections; and Fig. 20 is a partial horizontal section.

The cone, I, affords in its arrangement one of the characteristic points of the system. The entrance to it, in fact, contains grooves, *a*, that are designed to permit of its cooling, and to facilitate the condensation of the injected steam. It will be remarked likewise that the escape of priming water is not effected, as in the other systems, at the smaller diameter of this first convergent cone, which, after the passage that it leaves for such a purpose, is after a manner prolonged by the convergent cone afforded by the second tuyere, J. Fig. 19 shows that the priming or waste-water can escape from the apparatus only after having reached a certain height, and that a screw valve, D^1, permits, moreover, of the regulation of the orifice of expulsion, such arrangement preventing the entrance of air during the operation of the injector. In Figs. 17 and 20 will be noticed the peculiar structure of the cock for admitting water, this consisting of a vertical partition which connects two horizontal pieces, C^2 and C', and which stops up the entrance of the chamber, A, of the injector when it is turned as shown in the cut, but which allows the water coming through C to pass each side of it when it is in a perpendicular position.

THE WIEB INJECTOR. (Figs. 21 and 22. One-twelfth actual size).—This injector is specially designed for application to locomotives. Fig. 21 indicates that the apparatus is mounted vertically on the hind face of the locomotive fire-box, to which it is attached through the lower chamber, C, into which flows water from the tender and through the upper force chamber, E. The chamber, A, of the apparatus is in a single piece. The two cones, I and J, which are likewise in a single piece, leave between them a space, H, pierced with holes for the escape of the waste water through the cock, D. The injector, properly so called, is connected with the upper chamber, E, by a cylinder, A^1, at whose summit there is located a stop-valve, K. The force-pipe, E^1, whose orifice may be closed by the valve, *a*, maneuvered by the handwheel, *b*, enters the boiler above the water-level and extends to about half its length so as to become heated very hot before discharging its water into the boiler. The waste-cock, D, is surmounted by a rod, *c*, provided with a lever-handle, c^1, and terminates in a screw working in a nut connected with a handwheel, *d*. When the injector is not working, and it is desired to superheat the water from the tender, this cock is closed, as is also the valve, *a*, that closes the entrance to the force-pipe. Through the same steam entrance, B, the steam may then be sent into the injector; this latter offering no other escape for it than the lower pipe of the box, C, which communicates with the

FEED-WATER INJECTORS OF DIFFERENT SYSTEMS.

Bellevert-Guyenot

Fig. 5.

Fig. 7.

Fig. 6.

Fig. 8.

Monpas

Fig. 23.

Fig. 24.

Cuau

Fig. 10.

Gresham

Fig. 1.

Fig. 2.

Fig. 13.

Fig. 12.

Fig. 15.

Fig. 16.

Fig. 17.

Kiersky

Fig. 11.

Fig. 4.

Fig. 14.

Deacon

Fig. 20.

Fig. 18.

Bowart

Fig. 3

Schaeffer & Budenberg

Fig. 9.

Hamon, Metcalfe & Davies

Fig. 25.

Fig. 19.

Wheeler

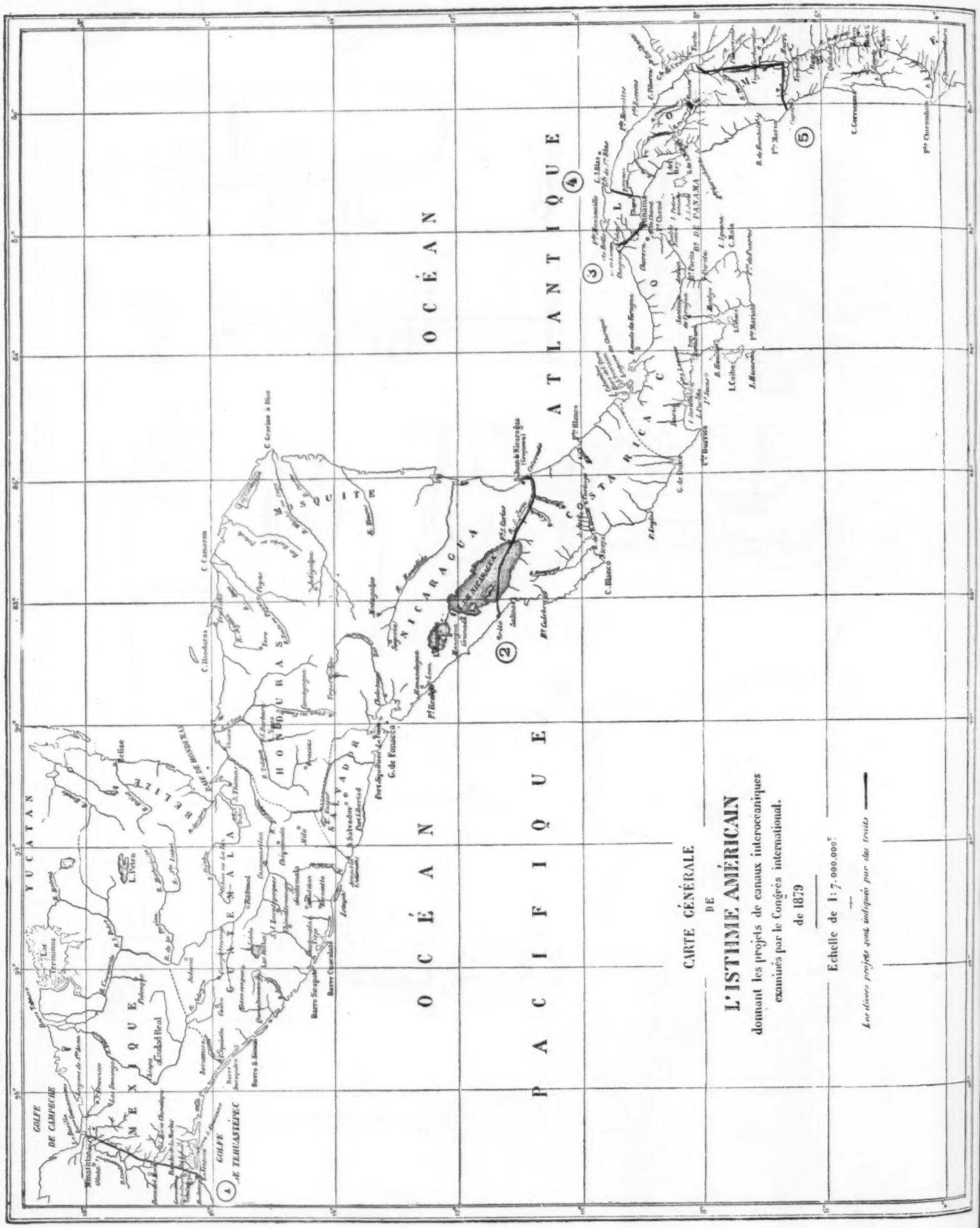
Fig. 22.

Fig. 21.

water reservoir. The coupling, L, on the pipe, A', contains a valve, *e*, maneuvered by the little wheel, e^1, and permits of taking the water of injection through a nozzle, *f*, to which is attached a flexible tube. The injector is thus enabled to take the place of a pump in case of a fire or for watering coal, etc.

ratus offering no remarkable peculiarity to point out. Fig. 23 gives a transverse section through the axis of this valve, and Fig. 24 gives a horizontal section. As will be seen, the valve, L, is located at the exit of the waste-pipe, D, and is constantly submitted to the action of a spring, L^1, fixed in a cylinder, M, and the tension of which can be regulated at

a single piece, is surmounted by the valve-cock, B, through which waste steam is introduced from the motive cylinder; and a nozzle, F, in whose center there is a conical piece, *a*, forces into the cone, I, and from thence into the cone, J, the water that flows to the injector through the pipe, C. The waste-pipe, D, through its siphon form, always retains a



CARTE GÉNÉRALE
DE
L'ISTHME AMÉRICAIN
donnant les projets de canaux interocéaniques
examinés par le Congrès international.
de 1879

Echelle de 1:7.000.000e

Les divers projets sont indiqués par des traits ——

THE MAZZA INJECTOR (Figs. 23 and 24. One-tenth actual size).—The interesting peculiarity of this locomotive injector is that it receives water not exactly under head, but under a pressure exerted artificially by the steam upon the special reservoir that furnishes it the supply; such water being then able to be superheated to a degree that could not be attained by the ordinary arrangements in use. This pressure is limited by a spring valve whose arrangement is the only point upon which we propose to dwell, the appa-

will by the nut, *a*. It will be understood then, that when the pressure inside of the injector exceeds the normal figure to which the spring has been regulated, the valve will rise and allow the water to escape through the spout, D^1.

THE HAMER METCALFE & DAVIES INJECTOR (Fig. 25. One-fifth actual size).—The principle of this injector is based upon the use of waste steam, which the motive piston forces to it instead of sending it into the air. It must be installed so as to receive water under head. The chamber, A, cast in

small quantity of water that prevents ingress of air. As may be seen, the cone, J, forms part of a sort of bell pierced with apertures, *b*, through which the forced water reaches the pipe, E. The cone, I, being screwed to J, and the latter being screwed into the lower part of the chamber, A, the two parts may be made to rise or descend a little by revolving them, so as to regulate the passage of water between the injection nozzle, F, and the entrance of the cone, I.

By means of a special arrangement the live steam of the

boiler may be substituted for the waste so as to cause the injector to operate during a stoppage of the engine.—*Machines, Outils et Appareils.*

[Continued from SUPPLEMENT No. 355, page 5663.]

THE PANAMA CANAL.

By MANUEL EISSLER, M.E., of San Francisco, Cal.

VIII.

WE now present a map of the Isthmus, showing the location of the principal canal projects. We also give illustrations of some of the existing working camps.

Principal Plans for Interoceanic Canals Examined by the International Congress at Paris in the Month of May, 1879.

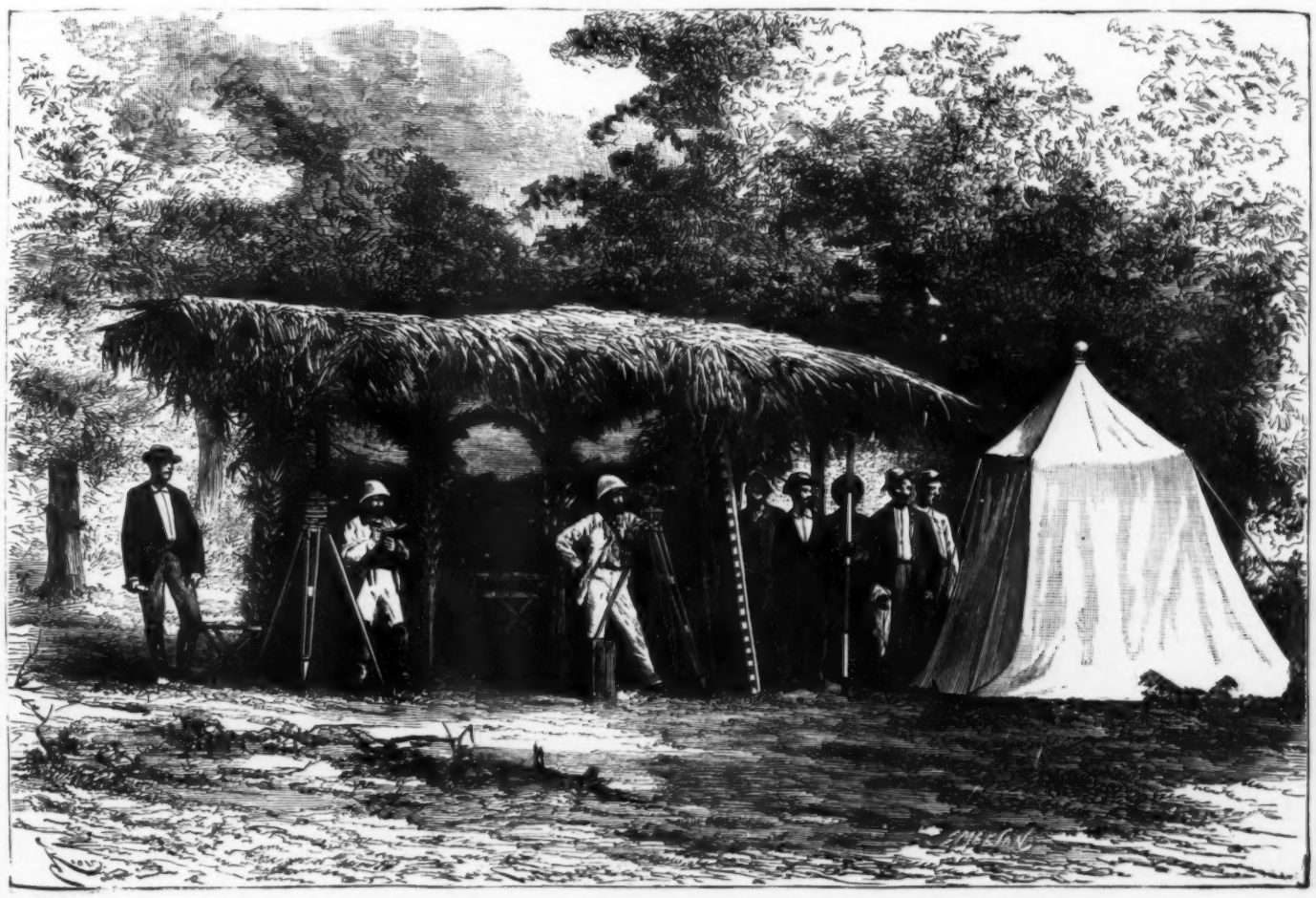
1. Tehuantepec Route:
   Length, 240 kilometers;
   Number of locks, 120;
   Time for passage, 12 days;
   None other but a canal with locks can be made.

2. Nicaragua Lake Route:
   Length, 292 kilometers;
   Number of locks, 17;
   Time of passage, 4½ days;
   None other but a canal with locks can be made.

3. Isthmus of Panama Route adopted by the Congress:
   Length, 73 kilometers;
   Time of passage, 1 day;
   Maximum height of the canal above the water, 87 kilometers for a length of 1 kilometer.

4. Isthmus of San Blas Route:
   Length, 53 kilometers;
   Length of tunnel, 16 kilometers;
   Time of passage, 1 day.

TEMPORARY CAMP OF THE SURVEYING BRIGADE COMMANDED BY MR. MOREL AT THE STATION D'EMPERADOR.



CAMP OF THE SURVEYING BRIGADE COMMANDED BY MR. FONTAN AT PARAISO.

5. L'Atrato-Napipi Route:
   Length, 290 kilometers;
   Number of locks, 2;
   Length of tunnel, 4 kilometers;
   Time of passage, 3 days.

NOTE.—The Suez Canal has a length of 166 kilometers, and 75,000,000 cubic meters of earth had to be removed. There was no railroad nor port available, and there was no supply of drinking water.

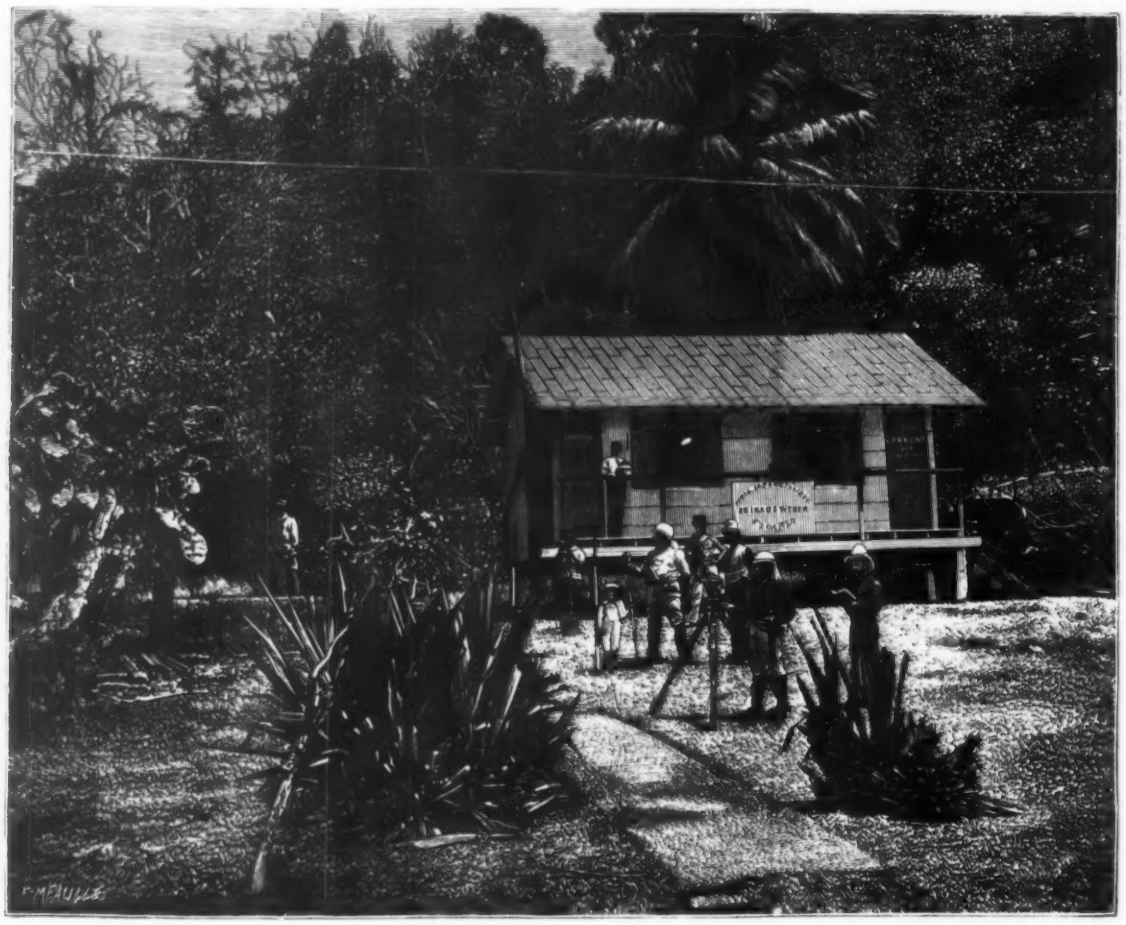
The Panama Canal requires 72,986,000 cubic meters of earth to be removed, and at each extremity there is a first-class harbor. A railroad runs alongside of the canal, and there is a good supply of drinking water.

THE SINKING OF THE HOLLANDISH MONITOR ADDER.

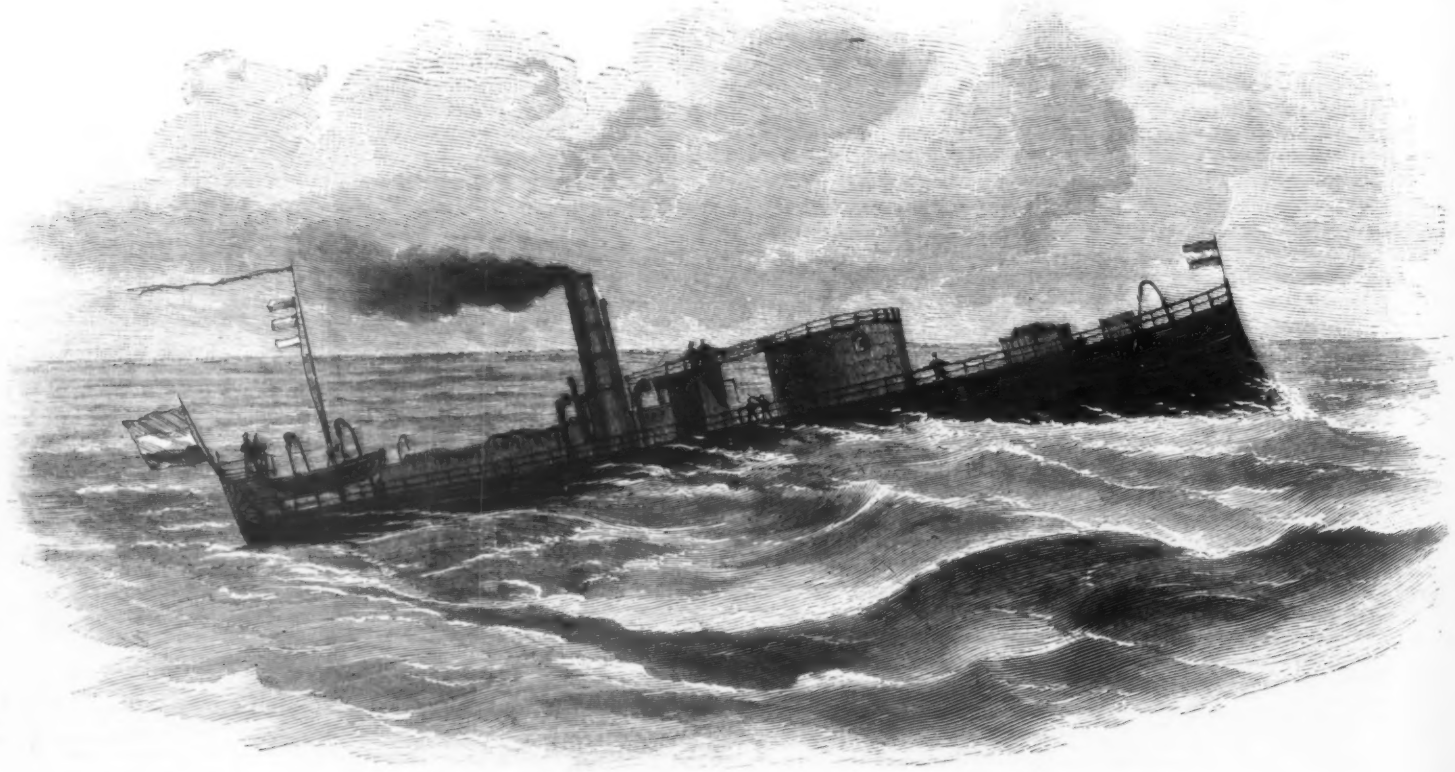
THE fearful catastrophe of the sinking of the man-of-war Grosser Kurfürst, at the Isle of Wight, a few years ago, has not yet been forgotten, and has lately been followed by a second accident of the same kind. The Hollandish ramming monitor Adder left Ymuiden on the 5th of July last to steam to Helvoetsluis, where the vessel was to be stationed, and during the trip sank with all on board—five officers, one surgeon, and sixty-two marines, engineers, etc. It was seen for the last time on the 6th of July by some Shevening fishermen, who followed the steamer for some time, and suddenly noticed a large quantity of steam arising from the vessel, and they surmised that water had entered the boiler room. A few days afterward kitchen utensils, parts of boats, spars, and several corpses gave more than ample proof that the Adder was lost. From notes found in the note-book of Lieut. Jongheer, who was on board, it seems that the vessel would not obey the rudder, and after vain attempts to return to Ymuiden, it proceeded in a south-easterly direction into the jaws of destruction. The monitor Adder was built in 1871, and cost about one million Hollandish florins. It had a displacement of 1,566 tons, engines of 680 horse power, and double screws, and a draught of about 8 feet 9 inches. The armament consisted of two Armstrong guns in the tower in front of the smoke-stack. The vessel never was a success as a piece of naval architecture, as it was too top heavy and had too many buildings on deck. The wreck was found on the night of the 21st or 22d of July, 1882, in a northwesterly direction from the light-house of Scheveningen, in ten fathoms of water.

WILLIAM STANLEY JEVONS.

WILLIAM STANLEY JEVONS was born at Liverpool, in 1835. As in the case of most men of intellectual work, the facts of his life are few and simple. He was educated partly at Liverpool, partly at University College, London, where he particularly distinguished himself in the classes of mathematics and natural science. For University College Jevons ever retained feelings of the warmest loyalty. He was proud of his connection with it and with the London University, and doubtless these feelings weighed with him when in 1876 he resigned his chair at the Owens College and accepted that of



CAMP OF THE SURVEYING BRIGADE COMMANDED BY MR. WEBER AT THE PARAISO STATION.



THE HOLLANDISH WAR STEAMER ADDER.

Political Economy at University College. Before completing his career as a student, Jevons accepted an appointment in the Sydney Mint, and spent five years (1854–59 in practical work abroad. At the close of that time his disinterested determination to devote his life and energies to intellectual work of the highest kind prompted him to return to England and to resume his interrupted studies. He graduated at London in 1862 with the highest distinction in logic and political economy, and a year later began his active career as a teacher in the capacity of general teacher at the Owens College, a post he occupied for three years. Even at this early period of his life, however, he had already produced not only an earnest of his great powers, but the germs of all the best work he afterward accomplished. A pamphlet on the "Fall in the Value of Gold," and an important work on the probability and consequences of the exhaustion of coal, sufficiently attested his mastery over concrete problems of economics. But of even greater significance was the short paper presented in 1862 to the British Association on quantitative reasoning in economical theory and the little noticed volume on "Pure Logic" (1864). The one contains the fundamental notions of the author's later work in theoretical political economy, the other the first principles and outlines of the development of his well known symbolical logic. In 1866 Jevons was appointed to the combined chair of Philosophy and Political Economy at the Owens College, and for ten years he discharged with the greatest ability and success the onerous duties of the office. During this time his practical activity was incessant and his intellectual labor continuous. In political economy his occasional contributions in the shape of papers in the *Statistical Society's Journal*, addresses or reviews, his important treatise, the "Theory of Political Economy," (1871), and his excellent manual on logic, his tract "Money; or The Substitution of Similars," his "Elementary Lessons on Logic," and his great work, the "Principles of Science," (1874), raised his reputation to the highest point, and it may be confidently said that no man ever obtained or deserved so thoroughly to obtain more widespread recognition as a master in these departments of knowledge. In 1876 the feeling that his time might with greater advantage to himself and the public be devoted to continuing his original researches, prompted his resignation of the laborious chair at Owens College. In that year he migrated to London and to University College, and for five years he continued to hold the chair of Political Economy in that institution. The same desire for more time induced him in 1881 to resign the comparatively light duties of his London chair, and he was doubtless enjoying the feeling of perfect freedom to devote himself to his beloved work when the abhorred shears cut short the thin spun thread of his life. A great force for good and a noble type of the man of science has been lost to us in Jevons.

The feature which perhaps impresses one most in reviewing the products of so busy a life, apart altogether from the fine and most lovable character of the man, is the combination of multifarious interests with uncommon tenacity in working out certain definite lines of thought. It is a feature peculiar to what is called genius and its presence, even when in less than a pre-eminent degree stamps the mind, exhibiting it as one of the highest order. Jevons' scientific training was excellent; his knowledge of the details of scientific work in many diverse branches truly universal; his interest in scientific questions and his love of scientific research of the keenest. A full record of the many contributions made by him to the great dictionary for the library of Chemistry and Philosophical Society in Manchester, to the *Philosophical Magazine*, and to our columns, it is hardly possible yet to produce, but it may be said that the character of his work, whether it be upon gold assaying, upon the forms of clouds, upon the motion of minute particles in liquids (a phenomenon named by him *pedesis*, and examined with long continued and loving care), or upon the connection of sun-spot periods with economic changes, is such as to prove him amply endowed with the finest qualities of the investigator of nature. Indeed there can be little doubt that had Jevons devoted himself to physical inquiry he had all the ability to secure a reputation possibly not inferior to that gained by him in other departments. He was an *exact* thinker, in the best sense of that term, and brought to bear upon great and economical problems a power of methodical, patient reflection comparable with that displayed by any of his contemporaries in the field of physical research.

In logic and political economy his numerous and varied writings have secured him a very distinct place in the first rank of writers. In both subjects he united, to a quite unusual extent, wide and comprehensive knowledge of details, with rare originality in handling scientific principles. His treatment of questions of detail, apart from his original contributions to the theory of either subject, would alone have secured for him a high reputation. Thus the "Principles of Science" contains a most exhausting and penetrating analysis of the methods of scientific work, illustrated from all branches of scientific research with a fullness and precision that leave little to be desired, while his various works and papers on economic and social problems, in the treatment of which he exhibited a most happy talent of effective exposition, constitute a contribution of very high value to the literature of political economy.

The permanence of his fame as a writer of the first order in his special subjects, however, must naturally depend upon the character and value of his original researches in the first principles of logic and political economy. As was above said these researches occupied Jevons throughout the whole of his active career as a writer, and his successive works are but the amplification and development of thoughts which had presented themselves to his mind at a very early period of his life. In political economy his thought was the reference of the laws of complex phenomena, such as prices, interest, and so on, to the simpler laws of pleasurable and painful feeling, the subjection of their simpler laws to quantitative treatment and the consequent application of exact, even of mathematical, methods to economics. He was too far-seeing and too judicious to overlook the enormous gulf that separates abstract economics from the domain of practice, and he was under no delusion as to the practicability of applying exact methods to phenomena so immensely complex as those of society, but within the domain of abstract theory he perceived the need for some more vigorous method than that usually employed, and his contribution is of rare value. Here indeed, as in logic, Jevons had to suffer a fate common to thinkers of undoubted originality, that of discovering that their new principles and new methods are not absolutely new. But in either science it may be safely said that if Jevons' contributions cannot claim novelty, they can always claim originality in the honest sense. They were thoroughly his own and were developed by him with ingenuity and exhaustiveness such as amply to establish his title to them. No man, it may be added, was ever more anxious than Jevons to do justice to the labors of his predecessors, and he was ever ready to welcome in the most generous fashion any indication of an anticipation of some favorite thought. His work was good enough, and he knew it was good enough, to stand upon its own merits.

In logic the system of formal or mechanical reference which Jevons worked out in great detail, was founded upon the antecedent researches of Boole. The processes, however, were presented by Jevons in such a fashion, the principles were so simplified and the capabilities of the method so ingeniously developed that his work has a secure place of its own alongside that of Boole. This is not the place for discussing the permanent worth of the new analysis of inference, but it may be said that hardly sufficient justice has yet been done to many of the speculations into which Jevons was naturally led in the development of his analysis. His treatment of the relations of logical and numerical quantity, and his attempt to deal with induction apart from all quasi metaphysical principles are bold and subtle contributions to logical theory, and, in connection with his other work in this department, they sufficiently establish his place as an original and thoughtful logician.

For philosophical speculation, in the wider sense, Jevons had little inclination, and possibly from the character of his intellect, little ability. Dealing with ultimate logical and economical questions he was often driven to the verge of inquiries such as fall under the designation of philosophy, to problems of the theory of knowledge and of ethics, but he never crossed the boundary, and indeed seemed somewhat impatient of the existence of a land beyond the formal relations of logical terms or the quantitative variations of pleasure and pain. This lack of interest in problems going to the root of logical and economical theory makes itself apparent in almost all his works, and probably, for many reasons, deprives them of some of their value. It is impossible to say, however, what genuine contribution to English philosophizing might not have been made had so original and well endowed a mind been spared longer to us.—*Nature*.

PROFESSOR F. M. BALFOUR.

THE lamented death of Mr. Francis Maitland Balfour, F.R.S., recently appointed Professor of Animal Morphology

THE LATE PROFESSOR F. M. BALFOUR.

in the University of Cambridge, was occasioned by a fall in climbing one of the spurs of Mont Blanc, the Aiguille Blanche de Peuteret, on the Courmayeur side. His Swiss guide, Johann Petrus, of Stalden, was also killed by this accident, which took place on the 19th of July, 1882. The body of Professor Balfour was found and brought to England by his brother, and has been interred at Whittingham, in Scotland. This gentleman had had a distinguished university career, having been placed second in the first class of the Natural Sciences Tripos in 1873, and elected a Fellow of Trinity College. He was Royal Medallist in 1881. He was an honorary LL.D. of Glasgow University, a Fellow of the Royal Society, and President of the Cambridge Philosophical Society.

CLOTH TRACINGS.

A CORRESPONDENT of the *Moniteur Industriel* refers to the difficulties encountered in tracing upon cloth or calico, especially the difficulties of making it take the ink. In the first place, the tracing should be made in a warm room, or the cloth will expand and become flabby. The excess of glaze may be removed by rubbing the surface with a chamois leather, on which a little powdered chalk has been strewn; but this practice possesses the disadvantage of thickening the ink, besides, it might be added, of making scratches which detract from the effect of the tracing. The use of ox-gall, which makes the ink "take," has also the disadvantage of frequently making it "run," while it also changes the tint of the colors. The following is the process recommended: Ox-gall is filtered through a filter-paper arranged over a funnel, boiled and strained through fine linen, which arrests the scum and other impurities. It is then placed again on the fire, and powdered chalk is added. When the effervescence ceases the mixture is again filtered, affording a bright colorless liquid, if the operation has been carefully performed. A drop or two must be mixed with the Indian ink; and it also has the property of effacing lead-pencil marks. When the cloth tracings have to be heliographed raw sienna is also added to the ink, as this color unites with it the most intimately of any, besides intercepting the greatest amount of light.

VARIETIES OF TANNED AND TAWED LEATHER, AND THEIR USES.

By W. A. VAN BENTHUYSEN, in the *Shoe and Leather Review*, Chicago.

THERE is no part of the world which does not furnish something in the way of hides and skins, which, after being subjected to various and more or less elaborate processes of manufacture, form the different kinds of leather known in commerce. The industry involved in such manufacture is probably as old as the human race, for the earliest records give accounts whereby we can judge with tolerable clearness of the proficiency of the most ancient peoples in manipulating the hides and skins of animals to adapt them for man's use. Farther back, even, than any written testimonials, we have undoubted evidences of the state of the leather finisher's art in the sculptured monuments of the valleys of the Nile and the Euphrates, and among the least civilized people of to-day we everywhere find some practical knowledge of methods for curing or dressing hides and skins to better adapt them to supply human wants and necessities. The Esquimaux in the north of America, the original Indians who have never learned from the white man, the natives in the interior of Africa, the tribes that roam over the steppes of Central and Northern Asia, as well as the inheritors of the older civilization of China and India, all have certain processes of treating hides and skins to cure and adapt them for service for clothing, for protection from the elements, or for personal ornament and display.

And the kinds of goods or productions coming under the generic name of leather are not only as numerous as are the races of animals upon the earth, but the number is multiplied by the varieties of materials used to effect a cure—a tawing, or tanning of the raw hide or skin—and by the widely differing methods by which these changes are effected. A bare enumeration of the names by which the various products are known in the commercial world would fill a volume, many of them varying by such slight degrees that only an expert could mark the difference. By far the larger proportion of the leather manufactured for boots and shoes is made from the hides and skins of animals of the bovine genus, the heavy hides of full-grown animals being generally used for sole leather, for machine belts, and for harness, the principal supply for such purposes coming from the oxen, cows, steers, and bulls domesticated in nearly every country in the world, the wild herds of the South American pampas, the Calcutta buffalo, and the American bison, the latter, however, fast becoming extinct. The lighter hides of the above descriptions, with skins from calves and partially grown animals, afford our principal supply of what is used for the manufacture of leather to be made into the uppers of boots and shoes and for other purposes, though this is largely supplemented by leather made from goat, kid, and sheepskins and horse hides, and in lesser amounts from the hides and skins of almost every animal known.

In the sole leather trade there are marked differences in the average character of the goods produced in various countries, arising principally from variations in the tanning materials used and the processes followed, but in all cases, even for relatively thin sole leather, a hide of comparatively heavy substance is used, as the design is to make a product more tough and unyielding, less permeable by water, and with less flexibility than any other description of leather. The highest standard of excellence in this department for many years was found in the English oak tanned butts. These were made of the heaviest good conditioned ox and steer hides, so taken off the animals that they were not injured by the butchers' knives, and from which were trimmed off the flanks, neck, and spongy part of the belly, so that only the most solid part of the hides was left, and this was subjected to a course of tanning that extended through fifteen to eighteen months in pure oak bark liquors. The leather thus made has never been excelled for sole leather purposes, and a great reputation was thereby built up for British tanners in every quarter of the world. With the increasing cost of oak bark, however, from the cutting away of forests and the enlarged demands of tanners, other tanning substances came to be used, and much shorter processes followed, which greatly lowered the value of the product. These more recently introduced adjuncts of and substitutes for bark were principally gambier or terra japonica, valonia, divi divi, and myrabolams, from the East Indies, the Levant, and tropical sections of South America and portions of Africa, with the mimosa from Australia. These new tanning agents afforded very strong decoctions, and heavy, good-looking leather could be made therewith, though not as serviceable for wear as that tanned with oak bark. The product in which these tanning materials were used gradually became known as of "mixed" tannage, and, although it was many years before English tanners generally failed to obtain credit for making their leather with oak bark, the actual quantity thereof peeled from the trees in Great Britain, with that imported, has not been sufficient, for at least a third of a century, to do more than from five to fifteen per cent. of the tanning done there. An extremely small proportion, therefore, of the total amount of leather manufactured in Great Britain is of pure oak bark tannage, while no very large quantity has even a small percentage of oak bark used in the tanning process, and the great bulk of the production is made by the use of these less valuable tanning agents.

Throughout Europe, as in England, oak bark has been the standard tanning material from which only the best sole leather could be made, but on the Continent, also, owing to the steadily growing scarcity of bark, other and less valuable tanning agents have been introduced, though not to the same extent as in England. It is to be remarked, however, that with the exception of a few large establishments, which can almost be counted on the finger ends, and most of which are in France, the sole leather generally made on the Continent of Europe has always been, and is now, decidedly inferior in substance and appearance, as compared with that made by the British tanner. The tanning of sole leather in central Europe generally, and in Russia, is conducted in so imperfect and unworkmanlike a way that the gelatine of the hide is not thoroughly made into solid, good wearing leather; the quantity of bark used, owing to its high cost, is insufficient, and the leather is easily saturated with water. The same general characteristics, also, mark the sole leather production, so far as this industry is prosecuted, in most countries not directly in contact with a vigorous commercial life, the pores of the hide not being well filled with tannin, and the leather in some cases being but little removed from raw hide.

The sole leather of the United States has a character more decidedly its own than have the productions of any other country. There are three general kinds, oak, "union," and

hemlock. The oak leather is tanned exclusively with oak bark, as the original forests still remaining in the country furnish this tanning material in abundant supply, and at an average cost of scarcely one fifth the value of oak bark in any part of Europe. The details of the manufacture, however necessary to insure thoroughly good workmanship, are not always so carefully looked after here as in Great Britain and in some few of the leading tanneries on the Continent of Europe, nor are the selections of hides so closely made to insure a uniform production, and in consequence there is a wide range of quality, much of this oak-tanning being equal to any sole leather produced in the world, while a considerable proportion, notwithstanding the fact that the best tanning agent is used, will not rank above that more carefully manufactured with inferior tanning materials in Europe. But it is for its hemlock sole leather that the United States is most distinctively known, in the manufacture of which are used tan liquors from the bark of the hemlock tree. This branch of the business first became of importance about 1830. The leather thus made is generally of a bright red color, though sometimes the shade is quite light, instead of the creamy white which oak tannage gives. European leather dealers, when they first saw hemlock leather, said it was only raw hide colored or stained, but it rapidly made its way into general use, until it now constitutes more than one-half the sole leather made in the United States, and for the last ten years has been largely exported to Europe. As the leather shows, the hemlock bark has more coloring matter than oak bark; it has also slightly more resinous and other extractive matters than oak bark, but the tanning principle is present in about equal proportions in average qualities of the two kinds, and as solid, tough-wearing soles, affording equal resistance to water, can be made from hemlock as from oak. Hemlock sole leather is nearly all made from "dry" hides, so styled from their being dried in the sun to preserve them, after being taken off the animals, instead of being salted or pickled, although the hides are frequently damaged in the drying. Beside liberal quantities received from Texas and California, large importations are made from South and Central America, Mexico, the West and East Indies, and Africa, the hides received from each section having well understood characteristics, and making leather of differing values accordingly. The "union" tanned sole leather, which forms an important manufacture, takes its name from the fact that both hemlock and oak bark are employed in the tanning. A small proportion only of oak bark is used, and this is principally to give a fair color to the leather, but carefully selected "slaughter" or salted hides are used, the same general care is used in the tanning as in the making of oak sole leather, the less valuable parts of the hides are "cropped" or trimmed off to be sold separately, and the "crops" or "backs" of this description of this leather sell at prices very nearly equal to those obtained for pure oak-tanned leather.

The sole leather made in Australia, where this industry has for a few years been of considerable importance, is principally tanned with mimosa bark, and, although it does not rank as equal to hemlock sole leather in wearing qualities, it is largely used in meeting the demand for common goods, both in that part of the world and in Great Britain, to which the annual exports are quite large.

In the southern part of Chili, also, there has been a vigorous growth in sole leather tanning since 1860, the product being largely exported to Germany, where it is known as "Valdivia" leather, from the name of the port whence it is principally shipped. This is a solid, good wearing, fine working leather, lighter in color than hemlock, and to some extent preferred on that account.

The distinction between good sole leather and that generally used for the making of machine belts or bands, so far as this rests in the substance and texture, is more theoretical than practical, judging from the common usages of the trade. Although belt leather, especially if for small belts, should have greater flexibility than is called for in heavy sole leather, and the tanner should avoid filling the cells of the hide so thoroughly with tannin, that the natural position of its fibers may be disturbed as little as possible—these giving to raw hide its great tensile strength—this is acknowledged only in a general way as the correct theory, without much affecting the ordinary practice, which gives to belt leather the same tanning for substance as sole leather commonly receives. The hides, however, are always tanned whole, and care is taken to select such as are free from scars, brands, or cuts, so that the largest possible pieces of even and uniform substance may be cut from each hide.

In the making of leather for the harness manufacture, the distinction above noted as being mainly theoretical is practically carried out. Harness leather must be a great deal more flexible than either sole or heavy belt leather, and must have as high a degree of tensile strength as can be retained, while its surface must be fine, and such as will readily take a variety of different styles of finish. A lighter hide is, therefore, generally used, but even then there is no effort made to combine with the gelatine in the hide cells as large an amount of tannin as the latter will take; a more thorough working over of the surface is necessary, and a very considerable dressing or stuffing of tallow and grease, which, with the coloring, bring the product in some cases very nearly to the substance of an upper leather.

As we get to the lighter leather used for harness purposes, upper leather for boots and shoes, and goods for miscellaneous uses, the tanning proper, although still a matter of main importance, loses some of its former purpose, and the work of the currier and finisher then becomes a prime essential in the manufacture. The skins and the thinner hides used to make upper leather do not contain as much gelatine in their cells as the thicker ones used for sole leather, and they are not treated with the strong bark infusions required for the latter, which would make leather too hard and brittle, and without the flexibility required in the upper of a boot or shoe. The kinds of upper leather are much more numerous than are those used for soles, and the qualities vary more widely, but by far the larger proportion of the goods made for such use, from the skins of calves and partially grown cattle, as well as those from larger hides, split, are tanned with the same tanning materials as are used in the manufacture of sole leather. The hides and skins are more thoroughly worked and broken, to give them suppleness, for which also, as well as to help the leather to better resist water, or to receive the finish for which it is designed, it is more or less completely saturated with oil, tallow, and wax. In Massachusetts, which is the headquarters of this department of the leather industry in the United States, gambier is used to a slight extent in the manufacture of the cheaper grades, and this is the case in all sections where bark is scarce, gambier and other tanning agents beside bark entering largely into the manufacture of upper leather in Great Britain and throughout Europe, although the finer qualities of calfskins are almost exclusively bark tanned. The fine calfskins for which the tanners and curriers of France and Germany have for many years had a world-wide reputation are principally tanned with oak, and in some cases willow and birch bark, by a long and careful process; only the choicest skins are selected, and a great deal of hand labor is given to every detail, so that the leather shall be as fine and soft as possible, while still possessing the highest degree of strength and toughness. The upper leathers principally used in the manufacture of staple goods—grain, buff, split, wax upper, etc.—receive their names from the style of finish, or their substance. A grain leather indicates one finished on the hair side of the skin, and showing a little unevenness of surface, irregularly marking the location of the original hair cells, while a buff is also finished on the grain side, but the unevenness of the grain is buffed off, leaving a fine, smooth surface. Wax calfskins and wax upper show a different style of smooth finish, the work being done on the flesh side. Primarily all these kinds, except those designated as splits, were supposed to include only leather made of the whole thickness of the skin or light hide, with just sufficient shaving down of the flesh side to give a smooth surface and even substance, but practically a large part of the upper leather now made in the United States is split—being made from hides thick enough, when tanned, to afford two surfaces, each part that was exterior being then differently finished. All the large hides and sides of patent and enameled leather for harness and carriages are of split hides, the hides used for this purpose being of the largest "spread" which can be obtained, and three splits frequently being made, the first taken from the flesh side being then known as a "junior." These small splits do not make leather strong enough to meet with a demand for shoe purposes, except to a very small extent in the cheapest goods, but are largely employed in the trunk manufacture, and for many minor uses. A good deal of "grain" leather is, however finished from inside splits, a good imitation of the effect which the natural hair surface of the hide would leave in the leather being made by special working and running between stamped rollers. The use of split leather in boots and shoes was first adopted in the United States, where it is still more largely used than anywhere else. Great Britain receives yearly large quantities of small East India hides, which afford their staple raw stock for upper leather; it is principally finished without splitting, and, retaining the full natural structure of the skin, forms a product better qualified to stand the test of wear than can be obtained in split leather.

Next in importance to the supply of leather from the hides and skins of bovine animals should be mentioned the distinctive productions afforded by goatskins, ordinarily known as morocco. This name for such leather did not arise because goatskins were first so utilized in Morocco, but from the fact that the Moors in North Africa and in Spain became celebrated for, and attained a degree of skill in the manufacture of fine colored and serviceable leather from goatskins, which has never since been excelled. There is no very marked difference now in the character of the goods made in the United States and Europe, counting the average productions of leading houses, from similar kinds of raw skins. The tanning is principally done with sumac, that from Sicily as well as of home growth being used in the United States, and both aniline and vegetable dyes being employed for coloring. Although the term "morocco" at once suggests to those not familiar with the business that considerable quantities of such leather must be used for bookbinding, the amount so employed is comparatively small; genuine Turkey morocco for binding is but rarely met with in the United States, and very little used in Europe, equally good goatskin leather for the purpose being made in many countries. A small quantity of fine and beautiful morocco is still made in Turkey, but the bulk of the world's production is manufactured elsewhere, and is principally used for slippers, light shoes, etc., while the cheaper sheepskin, split and finished and colored as desired, constitutes probably nine-tenths of all the leather used in bookbinding.

The number of uses for which leather made from sheepskin is employed are almost numberless. Sheep are raised in large numbers over so great a portion of the earth's surface that the supply of raw skins is immense, and, tanned with either bark or sumac, or tawed with alum, it can, although possessing much less strength than the goatskin, be finished to imitate almost any description of light leather. It fills a large place for linings and facings in boots and shoes; its use for bookbinding far exceeds that of all other kinds of leather together; it is almost the only kind of leather employed for hat linings, and for pocket-books, ladies' belts, satchels, toilet cases, furniture coverings, and the thousands of lesser articles in which leather is used, sheepskin is more employed than any other kind, particularly in articles to be sold at a low price.

"Russia" leather, as it is called, holds an important position in the manufacture of many kinds of fancy goods, but leather really made in Russia now forms but a small part of that which goes under this designation. The leather itself is generally made either from a light cow hide or a calfskin, and the tanning proper does not differ from that usual for light leathers, but the distinctive color and smell made the leather popular all over the world many years before it was manufactured anywhere else than in Russia. It was finally discovered, however, that its peculiar smell was due to the use of a small amount of birch bark tar, while the color was easily attained either with vegetable or aniline dyes, and, within the past ten years, a similar leather has been made in many countries, some of it even better than that made in Russia, but a large proportion much inferior, split sheepskins, thus manipulated, having found a large sale.

The manufacture of kid skins for fine shoes has attained considerable growth in the United States in late years, but France and Germany are still largely ahead of the rest of the world in this branch of business, as they are, likewise, in the production of kid for making gloves. Lambskins, as also those of the dog, cat, rat, and mole, are likewise used for gloves, while deerskins are principally employed for the heavier buckskin gloves and mittens. All these latter varieties of goods are rather tawed than tanned, and are generally classed as alum tanned.

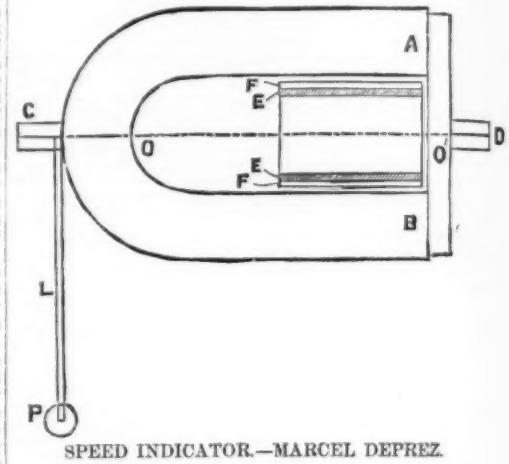
An important branch of the leather industry in Europe, but one of comparatively little extent in the United States, is the making of what is known as "cordovan," from horse hides, for the uppers of boots and shoes. Only a portion of the whole hide is suitable for such use, but a light and cheap upper is made therefrom, and finds sufficient use to form no inconsiderable contribution to the common stock of goods for wear on the feet.

Among the less important varieties of leather, which, however, fill sufficient space in the trade to be deserving of mention, are the lightly tanned or tawed goods from the kangaroo skins of Australia, used for boot and shoe uppers and linings; saddle seatings, for harness makers, made almost exclusively of hogskins; alligator leather, a more odd than very useful article, employed in the shoe manufacture, for satchels, etc.; shagreen from the skins of asses, camels, and mules, tawed, and, with plain or gay colors, much used in parts of Russia, Turkey, and Northern Africa for horse trappings and personal ornamentation; porpoise and seal skins, variously finished for shoe purposes, hunters' trappings, etc.; walrus hides, furnishing a very thick leather for polishing wheels; parchment, for writing or printing, from a variety of thin skins, as well as from sheepskins—the specimens we have of such manufacture going back to almost the earliest records of the human race. Snakeskins, as well as fishskins of many varieties, have frequently been tanned, principally as curiosities, but going far to show that there is hardly any hide or skin of living being from which something in the nature of leather, in some of its varieties, cannot be made, even the skins of human beings, revolting as it may seem, having occasionally been tanned and worn in boots and shoes.

ELECTRO-MAGNETIC DETERMINATION OF THE MECHANICAL EQUIVALENT OF HEAT.

By M. MARCEL DEPREZ.

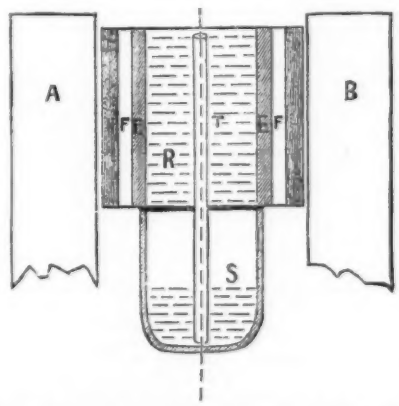
THE experiments hitherto made to determine the mechanical equivalent of heat have given numbers which vary between 420 and 432. The errors arise chiefly from the imperfect process which serves to determine the labor expended. The method proposed by M. Marcel Deprez de-



SPEED INDICATOR.—MARCEL DEPREZ.

A, B, Horse-shoe magnet.
C, D, Knife edges.
E, Iron tube.
F, Copper tube.
The two tubes turn concentrically round the axle, O,O'.
L, Lever supporting the weight, P.

pends in principle upon a measurement of the effects of induction in the Foucault disk. To understand this method, it is necessary, in the first place, to remember the magnetic speed indicator of M. Marcel Deprez. This apparatus is composed of a horizontal horse-shoe magnet, bearing two knife edges upon its axis. Between the poles of this magnet is an iron tube, surrounded by a copper tube, to which a rapid rotary motion is imparted. The effects of induction tend to attract the magnet in the direction of the rotary motion, and it is necessary, in order to maintain equilibrium, to counterbalance this action by the aid of a counterpoise,*



APPARATUS FOR MEASURING THE MECHANICAL EQUIVALENT OF HEAT.—MARCEL DEPREZ.

A, B, Ends of the revolving magnet.
E, Tube of iron.
F, Tube of copper.
H, Envelope of swan's down.
R, Interior of tube inclosing sulphurous acid.
T, Tube of communication.
S, Sulphurous acid condensing chamber.

suspended at the extremity of a horizontal lever, perpendicular to the common axis of the magnet, and the revolving copper and iron tube.

Knowing the speed of rotation and the couple which equalizes the inductive action, it is very easy to deduce therefrom the inductive energy absorbed by the system, energy which is transformed entirely into heat.

To obtain a constant speed, the copper and iron tube is set in motion by means of an electro-motor provided with a

* In the speed-indicator, properly so called, the magnet, which has been properly tested, is inclined at a certain angle dependent on this speed, and it is this angle which permits of its determination.

centrifugal interrupter, invented by M. Marcel Deprez. We can thus, and this is the preferable means, utilize the tendency to displacement of the magnet, under the influence of feeble variations of speed, to break or close the circuit of the electric-motor which actuates the apparatus. The speed varies then only to a very small degree. The speed-indicator is therefore transformed into a Foucault disk, with a constant speed and of a peculiar form, in which the quantity of inductive energy, transformed into heat, is measured very exactly by means of the speed of rotation, and of the couple which equalizes the magnet. It is important to observe that this method eliminates all passive resistances, only taking account of the inductive energy transformed into heat in the copper and iron tube. It remains now to measure the quantity of heat given out in the system in rotation.

To this end M. Marcel Deprez applies the principle of the sulphurous acid calorimeter of M. D'Arsonval. The apparatus designed for measurement comprises a movable magnet and a fixed copper and iron tube, that is to say, an arrangement the reverse of that for the speed-indicator. The interior of the fixed tube, closed at both extremities, is filled with sulphurous acid in communication by a small tube with an external reservoir. The evaporation of the sulphurous acid and its condensation in the external tube are effected by the most slight elevation of temperature. The volume of acid condensed in a given time indicates the number of calories furnished by the apparatus. Condensation occurring at the temperature of the surrounding air, there is no correction to make in this respect. In order that the feeble elevation of temperature of the tube of copper and iron may not produce any radiation and any loss of heat, this tube is enveloped in swan's down, which opposes radiation.

The tube being fixed and the magnet movable, the tube tends to be attracted by the magnet. The torsion couple is equalized by a platinum wire, the effect of which is measured, applying the laws of elasticity.

We have thus, on one hand, the exact measurement of inductive energy, and on the other hand the measurement of the heat liberated by this inductive energy. He deduces from it directly the value of the mechanical equivalent of heat, writing that the inductive energy in a given time, when the *régime* is established, is equal to the heat evolved deducted from the quantity of sulphurous acid condensed during the same time, multiplied by the mechanical equivalent of heat, the only unknown quantity in the problem. The apparatus is constructed with great accuracy, and gives the hope of determining the mechanical equivalent of heat as near as one one-thousandth owing to the ingenious method of which M. Marcel Deprez has just presented the principle to the association.—*Electrical Review.*

ELECTRICAL INCANDESCENT LAMPS ACTING IN THE OPEN AIR.*

By M. EMILE REYNIER.

THE process of incandescence in the open air, which I made known in 1878, is now abandoned. Various causes brought this about; not to mention those of a technical order. I recognize that my old lamps have a rather low photometric effect; that certain of their parts are delicate, and call for attentions sometimes incompatible with the requirements of practice.

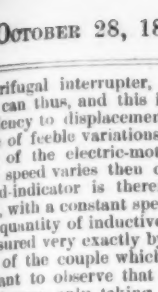


FIG. 1.

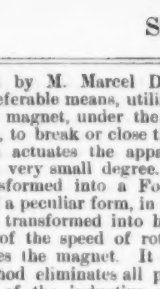


FIG. 3.

But these defects, connected with one system of lamp, and to the dispositions which have been given to it, are not inherent to the process of incandescence in the open air itself. I was therefore able to seek, with the same view, new systems, giving, like the old one, a white and fixed light, and in which the defects recognized in the old lamps will be eliminated or decreased. It is the results of these new researches which I wish to explain clearly.

I shall only illustrate by figures the principle of my old system (Fig. 1) and its most usual form (Fig. 2), to bring immediately to the fore the description of the unpubli-hed details.

SECOND SYSTEM.

With a given electric conductor, one can considerably increase its resistance by cutting it transversely in various places. The increase of resistance is more considerable in proportion as the sections are more numerous and smaller.

Fig. 3 shows a conductor of graphite composed of a certain number of superposed layers, moderately pressed together between two contacts. Such a conductor, mounted in a transparent, hollow, and completely closed receptacle, would constitute a good electric lamp; but its construction gives rise to difficulties which have not been overcome.

In air the combustion of the incandescent carbon necessitates the renewal of the material of the luminous matter. This is how the difficulty may be surmounted.

The dissected conductor is composed of the converging extremities of small rods of carbon, which come together between the two contacts, A and B (Fig. 4); each rod is traversed, transversely and at its extremity only, by the electric current. With n carbons, one obtains $n + 1$ contacts. The renewal of the carbon as consumed is brought about by the continual progression of the carbons, which coincide, like the *voussoirs* of an arch, of which the contact pieces will be the piers.

FIG. 4.

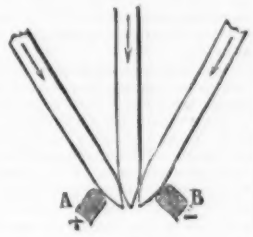


FIG. 5.

The arrangement indicated in Fig. 4 is only realizable with very thin carbons in the transverse direction; carbons of round or square section take a wolf's tooth form (Fig. 5), which is unfavorable to the luminous effect of the apparatus, for the points relatively cold which stand out from the dissected conductor are the seat of a very important superfluous emission of heat.

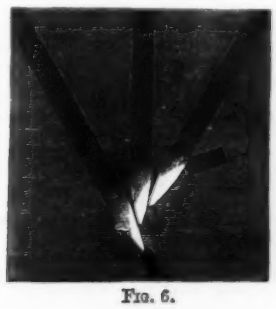


FIG. 6.

We have overcome this difficulty in the arrangement, Fig. 6. The dissected conductor describes a broken line, and the current, traversing the end of each rod obliquely, leaves no point out of circuit. Fig. 7 represents an electric lamp constructed upon this principle. The carbons, guided between two pumice-stone plates, are respectively propelled toward the opening of the lamp by unequal weights, sliding in grooves made in a brass triangle. The insulated pieces, A and B, serve as stops and as terminal contacts.

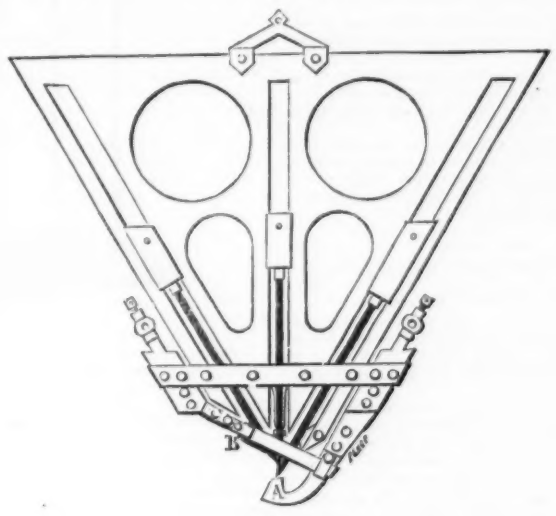


FIG. 7.

This lamp acts well, but we must wait to judge of it, until it is provided with carbons of a very flattened section, which will allow of multiplication and of approximating the contacts, to simplify the lamp and diminish its size.

Provisionally, I prefer the following recent invention, which is more simple, less voluminous, and acting with any carbons whatever.

THIRD SYSTEM.

I utilize here the thin form which we notice in the two preceding systems.

FIG. 8.

FIG. 9.

FIG. 10.

There are two rods of carbon made thinner at one end (Fig. 8); they are placed in the same plane, almost parallel to each other, and are approximated until they touch; their point of contact, x, will be situated above the points, toward the base of the cone. The points being free, one can make them rest upon two contacts, A and B (Fig. 9), and thus obtain an incandescent system in which the electric current traverses successively, in the opposite direction, the two pointed ends, passing from one to the other by their lateral mutual contact.

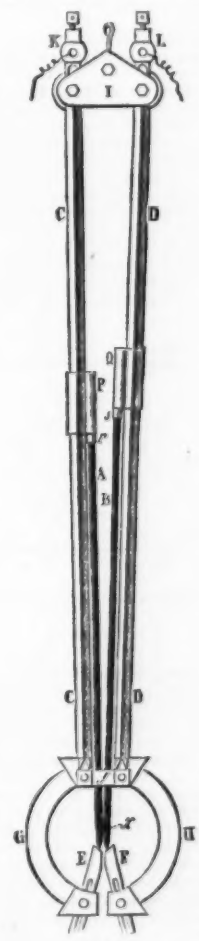


FIG. 11.

To maintain the parts in this condition, notwithstanding the combustion of the points, it is necessary continuously

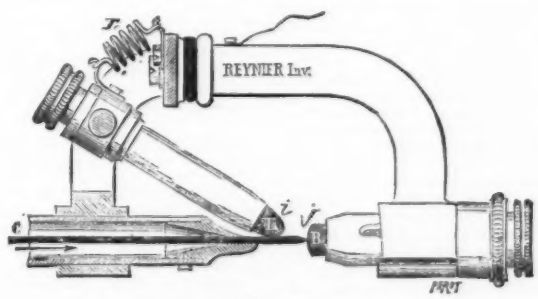


FIG. 2.

* From a paper recently read before the French Association.—*Electrical Review.*

to impel the carbons, in a longitudinal direction, and to give to the supporting contacts a suitable obliquity (Fig. 10): the rods ought also to be guided in their common plane. Under these conditions, the pointed form is maintained; the carbons continue to impinge upon their respective contacts, and to touch each other at a certain distance above the points. Fig. 11 represents one practical form given to the apparatus. The carbons, A and B, are respectively impelled by weights, P and Q, sliding upon two metallic guides, C and D. The oblique contacts, E, F, are two sheets of copper, fixed upon bronze arcs, G, H. Two pairs of insulated clamps, I and J, connect the two halves of the lamp; the first pair is of wood, the second is of slate, and forms a slot, which guides the two carbons in their common plane.

The weights, P and Q, are insulated from the carbons which they impel, by ivory caps, *r* and *s*.

The electric current, entering by the terminal, K, follows the brass guide, C, the bend, G, the contact, E, goes up the pointed extremity of the carbon, A, passes over the contact, *x*, descends by the carbon end, B, and follows the contact, F, the bend, H, and the guide, D, to the terminal, L.

The two extreme contacts make little shadow; the middle contact causes no loss of heat or light, and usefully increases the total resistance of the lamp.

This combination of two very approximate incandescent points, and of three neighboring contacts, procures a concentration of heat favorable to the photometric effect of the apparatus.

The experiments in progress will give, on this point, figures which will confirm the favorable impression produced by the first trials.

The apparatus is simple, easily manipulated, and of certain action; its narrow and symmetrical form allows of using it everywhere.

As to the necessity of renewing the carbons daily, it has been necessary, up to this day, to submit to it in all systems capable of giving *white* light with a good photometric effect.

The most grave defect of my incandescent lamps is their too feeble resistance, which necessitates the employment of intense currents, the transmission of which is costly.

From this point of view, the third system is superior to the first, but inferior to the second.

A DIFFERENTIAL ELECTRIC THERMOSCOPE.

By W. F. NOSWORTHY.

IT has of late frequently been pointed out to students and others that little real progress can be made in any branch of science from the cursory reading of a book; that by experiment alone can such subjects be successfully grappled with.

This is undoubtedly true; but it must be remembered that by far the greater portion of such persons are unable to attend lectures, join societies, or otherwise avail themselves of the facilities offered to those who have the good fortune to reside in London or other large city where these institutions exist, while the excessive cost of scientific apparatus, even of the most elementary nature (frequently exceeding many times the intrinsic value of the articles), forbids their procuring the necessary instruments wherewith to experiment at home.

This latter fact is undeniably a great obstacle to the progress of science, therefore whatever steps are taken tending to reduce the price of scientific apparatus generally will, I venture to say, be welcomed by all, and prove a material aid to science by increasing the number of workers in the field.

To persons engaged in the study of radiant heat, or even those who have occasionally to measure small differences of temperature, the possession of a thermopile is of paramount importance The cost of this instrument is about £4 4s.

The object of the present communication is to call the attention of those interested to a simple arrangement which may with advantage replace the thermopile, and be constructed by any one at a cost not exceeding five shillings.

It has long been known that the electrical resistance of a wire varies with every change of temperature, the resistance increasing with a rise and diminishing with a fall of temperature. This fact forms the principle upon which the instrument about to be described is based.

Four coils of fine, silk-covered copper wire are joined up with a delicate galvanometer and a couple of Daniell's cells as a Wheatstone's bridge (Fig. 1). If the resistances of the

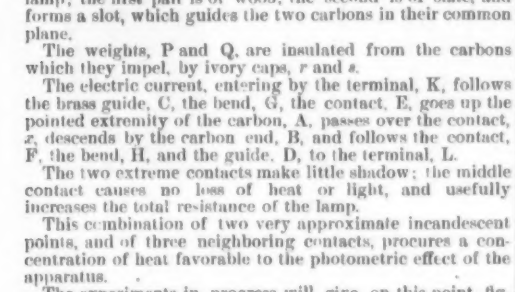


FIG. 1.

coils, *a*, *b*, C, C', are equal and at the same temperature, the points, D and E, will be at the same potential; therefore no current will flow through the galvanometer, G.

Suppose, now, the temperature of one of the coils, C, for example, be raised, the resistance of that coil will be increased and the potential of the point, E, thereby reduced relatively to that of D, consequently a current will flow through G in the direction from D to E, causing a deflection, say, to the left. On the other hand, if it be the temperature of C' that is increased the potential of E will be raised above that of D, and the direction of the current through G reversed, the deflection in this case being to the right. If, however, the temperature of both C and C' be increased or reduced by exactly equal amounts, no change will take place in the potential at E, and there will be no deflection of the galvanometer.

From what has now been stated Fig. 2 will be readily understood.

The two coils, *a*, *b*, (Fig. 1), are embedded in the base of the instrument, while the coils C, C', are supported, as shown, by the four glass tubes, *m n*, *o p*, *q r*, *s t*, through which the connecting wires from the respective coils pass to the terminals on the base. The battery may be connected to the terminals, B, A, and the galvanometer to D, E, or *vice versa*. Arranged thus the instrument forms a differential thermoscope of great sensibility, and can be used in every case where the thermopile has hitherto been employed.

In the instrument represented by the drawing, the four coils are composed of No. 40 silk-covered copper wire, and have a resistance of 20 B. A. units each. The coils, C, C', are further coated with lampblack. The galvanometer used in connection therewith is an astatic mirror, of which a section having a resistance of 125 ohms has been employed.

It will be seen that the relation between the resistance of the galvanometer and coils is not such as to give the maximum sensibility to the arrangement, nevertheless the comparisons made between this instrument and a thermopile of forty-eight pairs of antimony-bismuth plates, having a resistance of 1·4 units, and joined up with an astatic reflecting galvanometer of 1·5 units resistance, specially constructed for use with the pile, are extremely satisfactory, for when a source of heat is placed equidistant from the two the galvanometer in connection with the thermoscope invariably gives the highest deflection, and is also the first to sink to zero when the source of heat is removed.

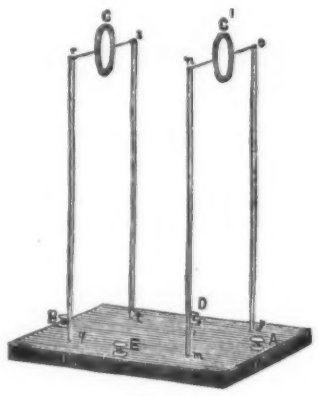


FIG. 2.

For those who have not the means of measuring the resistance, the coils may be made of equal lengths of wire. As, however, owing probably to mechanical defects in manufacture, two equal lengths of the same wire seldom have exactly the same resistance, it will be necessary to finally adjust the coils by adding or cutting off a small piece of the wire until the galvanometer shows no movement when the battery circuit is closed. Sufficient time should elapse between touching the coils and making this trial to allow the wire to assume the temperature of the atmosphere, otherwise the coil last touched will appear to have the greatest resistance

Many improvements in the construction of the instrument will readily suggest themselves, the form shown in the figure has, however, answered all my requirements indeed since its completion I have seldom used the thermopile.—*Electrical Review.*

EARTH TREMORS.*

THOSE of our readers who remember an article on Earth Tremors published last year (the *Times*, November 12, 1881) will perhaps be glad to hear the outcome of the experiments therein described. The article has not only stirred up interest in the work of the Darwins at Cambridge, but it seems also to have borne some fruit in places where the soil is even shakier than they found it in the Cavendish Laboratory. In Japan, for instance, we learn from Professor Milne that fresh attention has been called to the remarkable earthquake phenomena of the region, and his hands have been strengthened in the praiseworthy efforts he has been making to secure their ordered and accurate observation. The instrument designed to make out and measure the deflection of the plumb-line due to the varying attraction of the moon was found last year to be too sensitive for its purpose. Or rather, when all means had been taken to make it sensitive enough to record the lunar disturbance, unlooked for disturbances of another kind were encountered. These were so incessant and so lawless, that the steady march of the lunar swing was utterly overborne and lost. The earth was never really still. It quivered and throbbed and warped and bent under the pendulum night and day, and even as it seemed in the absence of all merely local agencies that could be detected. The steady soil of Cambridge was, in fact, found to be subject to a ceaseless series of microscopic earthquakes. There was no reason to think that places less grave would have a steadier soil, and so Mr. George Darwin was driven to look to the bottom of a deep mine as the only hopeful site for his gravitational observatory.

In the report read by him the other day to the British Association, this hope is done away. For reasons that are not to be gainsaid it now appears that the measurement of the lunar disturbance of gravity must long remain impossible with any instrument on the earth's surface, or at the bottom of the deepest mine that is likely to be dug. Steel is a pretty stiff material, but even if our globe be throughout every whit as stiff, its enormous mass makes it yield and warp under the changing stresses on its surface to a degree that altogether masks the direct lunar changes of the plumb-line. Mr. Darwin's instrument is fine enough to make manifest these latter changes, but nowhere on the earth or in its yet explored depths can he find a resting place for it that is firm and still enough. He wants a πού στῶ. At the bottom of a deep mine he might possibly get rid of the local disturbances due to traffic, changing temperature, soakage of moisture, etc. These were the more obvious troublers of the peace present to the observers' minds last year. But now they know that other disturbing causes of a deeper and wider reach must make themselves felt even when all the others are eliminated. These causes produce effects that are of the same order of magnitude as the direct effect of the moon, and are at present inextricably entangled with it. The causes are the varying mass of the air that shifts and changes as the barometer indicates, and th varying mass of the water on the shores that shifts an changes with the tides.

Once given that the earth can yield at all, it would not excite wonder to be told that a great mountain set down upon it would give rise to a wide-spread shallow depression of the surface. Sir William Thomson bids us think of a pile of sovereigns placed on the surface of a plate of stiff jelly, and picture the basin-like smoothly-sloping dimple they would cause. It is plain that the stiffer the jelly, the shallower will be the dimple and the less the strain. An idea of the strength and stiffness of the jelly may thus be gained by noting the amount and kind of yielding which results from known weights resting on it. Now the great continents and mountain-chains that rise above the general level of the earth must strain it just in this way. The earth must have a certain strength and stiffness that allows it to yield under them, but not to break. We can, in fact, calculate what stresses the actual mountain chains call forth, and so get a notion of the general strength of the materials of the globe that supports them. Mr. Darwin in a paper "On the Stresses Caused in the Interior of the Earth by the Weight of Continents and Mountains" ("Philosophical Transactions," 1882) has carried out this calculation with noteworthy patience and skill, and the results are sufficiently remarkable. All that need be mentioned here is that "it appears that if the earth be solid throughout, then at a thousand miles from the surface the material must be as strong as granite." If it be fluid or gaseous inside, the stiffness of the crust must, of course, be very much greater.

The yielding of the earth under a mountain mass is, we say, not hard to picture. But it was probably never imagined till now that when the barometer rises an inch over a land area like that of Australia, the increased load of air sinks the entire continent two or three inches below the normal level. Over a like sea area the water surface may be depressed a foot or more. Thus, though the continent sinks, it does not necessarily seem to sink into the sea. When such a barometric change occurs over a part of the dry land the result is easily seen—a sinking of the ground under the summit of the anti-cyclone or heaped-up mound of air, and a sloping depression all round extending many miles away from this center. Thus as the massive air sweeps in wind or creeps by slower convection from place to place, the yielding earth sways up and down beneath its weight. But it has yet another effect. When we imagined our mountain set down upon the earth, we saw that it would make the neighboring ground slope down toward it. A plumb-line hung up above a point in the slope would no longer be perpendicular to the surface. But the mountain would itself attract the plummet toward it, as in the famous Schehallion experiment. The two effects would be superimposed, and the apparent displacement of the vertical would be exaggerated. It is one of the most beautiful results in the report before us that these two effects are always proportional. The slope of the basin of depression varies as the attractive deflection due to the mass which gives rise to it. So, too, the mere attraction of the heaped-up air in an anti-cyclone goes to increase the deviation of the plumb-line already caused by the earth's elastic yielding under the weight of it. Mr. Darwin makes out that this twofold deviation is of the same order as that which the moon produces. Any pendulum which shows the latter effect must also be exposed to the former. The former is perpetually varying and incalculable; hence for this reason alone the pendulum observations must always be essentially vitiated.

If the consequences of the changing masses of air on the slope and flexure of the earth's surface are fully understood, it will be easy to foresee the effects of the ocean tides upon the shores exposed to them. Twice a day a vast body of water is thrown upon the coast, and twice a day retreats. Under the changing stress the yielding land sinks and rises, and the sinking and the rising make the flood-tide higher and the ebb-tide lower. It appears that along the Atlantic shores the long-period tides alone may make the land swing up and down through some five inches. And, of course, the advance and retreat of the water will also tell on the plummet by mere attraction. The lead will seem to be pulled seaward at high water, and will swing back landward at the ebb. At 60 miles away from the Atlantic coast the deflection due to tidal action of the kind described is probably quite as great as the greatest deflection due directly to the moon Now, these flexures are not confined to the surface layers only; they must extend in almost equal degree beyond the depth of the deepest mine. The state of the tides and the instantaneous barometric pressure for a radius of, say, 500 miles round any given spot, cannot be known with sufficient accuracy to enable us to calculate and so eliminate the effects they severally produce. Until this is done the experimental determination of the lunar disturbance of gravity is out of our reach. Our instrument, even in the most favorable site, must needs record incessant variations of which no satisfactory account could be given. The irrelevant deviations could not be disentangled from the relevant. A gravitational observatory must, therefore, for the present content itself with registering the more or less irregular tremors of the earth that are allied with earthquake movements. There is here a vast region much needing to be explored. The excellent work done upon it in Italy and Japan is full of high interest and promise. But it is work of a different class from that of which the British Association appointed its powerful committee. Its active members, the Darwins and Sir William Thomson, who began their labors with much hope of solving the special lunar problem set before them, have now shown that the solution is at present unattainable. They have thereby made a "happy dispatch" for the committee dies in making its report. But they have nevertheless done a great and singular service to science, for it is knowing much to know that we cannot know more.

* Second Report of the Committee consisting of Mr. G. H. Darwin, Sir W. Thomson, Professor Tait, Professor Grant Dr. Siemens, Professor Purser, Professor G. Forbes, and Mr Horace Darwin, appointed for the Measurement of the Lunar Disturbance of Gravity. (Written by Mr. G. H. Darwin.) British Association, 1882.

THE INFLUENCE OF DIFFERENT ACIDS ON FERMENTATION.

ALCOHOLIC fermentation is usually accompanied by other changes by which small quantities of different acids are produced, and these acids, which vary much in flavor and chemical properties, exert a very marked influence on the progress of the fermentation. This subject has been fully investigated by M. Maercker, who found that the presence of 0·5 per cent. of acetic acid, of 0·2 per cent. of formic acid, of 9·1 per cent. of propionic acid, of 0·05 per cent. of butyric acid, and only the merest trace of caprylic acid, were sufficient to interfere with fermentation, while the presence of 0·1 per cent. of butyric acid was sufficient to stop the fermentative action entirely. As these different acids are produced by the agency of minute organisms which often accompany ordinary yeast, it can be readily seen how easily a fermentation may be checked and stopped should any of these acids be developed. A microscopical examina-

tion of the yeast cells will show that their functions are interfered with, or even altogether suspended, in the presence of the above quantities of acids named; and, moreover, it will be observed that the shape of the yeast cells is considerably altered. Lactic acid, which is nearly always formed simultaneously with alcohol, on the other hand, appears to assist the vital action of the yeast cells; the presence of 0·5 per cent. of this acid is decidedly beneficial for alcoholic fermentation, and as much as 3·5 per cent. of lactic acid must be present to interfere adversely with the action of the yeast. These researches have considerable practical importance, for bearing them in mind, we may be able to account for the sudden stoppage of a fermentation which occurs from time to time in every brewery; careful search with a microscope would in such cases probably reveal the presence of some of the organisms which are known to develop the acids we have referred to.

THE ANIMAL HIDE.

By CARL SADLON.

I.

THIS chapter might be treated in two directions: on the one hand, we might consider the hides which are used in practice in relation to the animal from which they are derived, their age, the peculiarities due to climate, etc., or we may consider only those properties and characteristics which are possessed by every hide without exception, no matter what kind of leather is to be made from it. As the treatment of this question in the former direction does not enter the scope of this article, I will directly take up the second.

The most prominent authority on the anatomical structure of the animal hide, in my opinion, is Dr. Alexander Rollet, and I will give the most valuable and important facts relating to the anatomical structure of the hide, as given by him

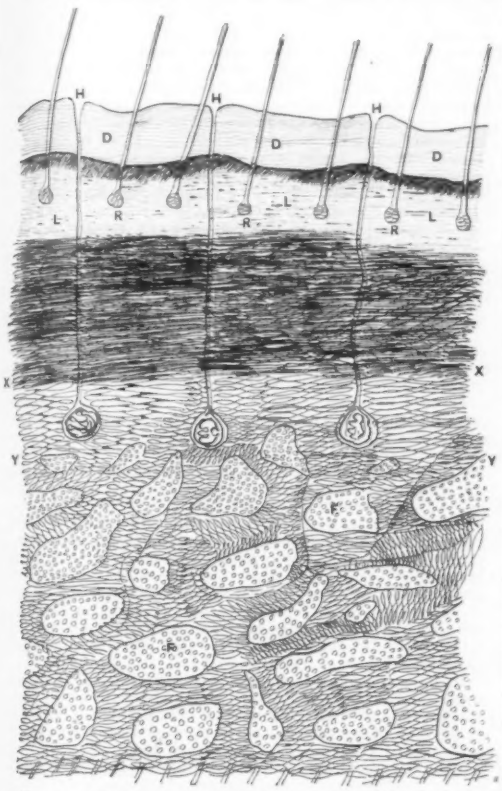


FIG. 1.—HIGHLY MAGNIFIED LONGITUDINAL SECTION OF SKIN FROM A TEXAS STEER

FIG. 4.—AFTER TANNING. VERY HIGHLY MAGNIFIED.

a—represents a lateral view of three fibers.
b—represents a lateral view of one perfect fiber.
c—represents a cross section of b.

We are indebted to the *Shoe and Leather Manufacturer*, through Mr. Nelson H. Darton, for the cuts and the following:
The skin is made up of three layers. The first, D, in Fig. 1, is the cuticle; the second, L, the *rete mucosum*, and the last and body of the skin, the *corium* below the lightly-shaded portion, L. This figure is a highly-magnified section of the skin untanned, but cleansed by washing. The cuticle consists of a highly-nitrogenized substance, very similar to horn; being quite dense, and having no affinity for the tannin, it must be removed before the remainder of the skin is tanned, as it would shield a portion of the part next to it from tanning, and thus itself and the adjacent part would decay in time, and by the acid gases evolved destroy the leather beneath it. This part and the hair upon it is therefore removed by the process of liming and the subsequent scraping on the beam, etc. The *rete mucosum*, L, is, a layer of fibrous matter about the same thickness and beneath the cuticle. It is here where the roots, R, of the hairs are implanted in little glands. This portion is a little denser than that below, but readily absorbs the tannin and forms the face of the leather, receiving all the polish, color, etc. The *corium* is the main portion of the skin; it consists of closely-interwoven fibers, holding near the under side the numerous fat cells, F, the perspiration glands, C, and their passages. Besides this it is freely interspersed with the channels to conduct the skin secretion mentioned before.

in vol. xxx. of the Reports of the Vienna Academy. From a chemical point of view, the extensive treatise of A. Reimer, published in Dingler's Journal, vol. ccv., under the heading, "Studien zur Wissenschaftlichen Begründung der Gerberei," is the most remarkable, and I will make use of the most important parts of it.

According to Rollet, the hide essentially consists of glue-forming membrane, which is organized in such a manner that the fibers, which can be seen by the naked eye, are formed by the agglutination of numerous fibrils. The fibers, however, by interweaving themselves, gradually rise to the surface of the skin, where they are resolved into their elements, the fibrils, which form the so-called *rete mucosum*. The inner membrane, which is mostly removed during the preparatory operations of the tanner (fleshing), I will not take into consideration.

The thickness of the fibrils is from two to three ten-thousandths of a millimeter, the thickness of the bundles of fibrils (fibers), three to six thousandths of a millimeter. The fibrils consist of smooth, massive cylinders, and in their principal direction run parallel to each other.

The fibrils which form the bundles, as well as the bundles themselves, are held together by means of an albuminoid substance. Schwan mentions this cementing substance as early as 1831, while Hermbstaedt, about thirty years previously, assumed the existence of such an intermediate substance, and even prepared it by extracting with lime water and precipitating with HCl. His explanation, however, was incorrect, for he thought it was a fat, separated from a soluble lime soap. Rollet, in his experiments, used lime water and baryta water.

He says: "Lime water or baryta water does not change the morphological character of the skin, it does not attack the glue-forming substance, but loosens its connection and permits the isolation of the fibrous elements. A further examination shows that while this mechanical change of the fibers takes place, the lime or baryta water takes up a small quantity of a substance which can be precipitated from these alkaline solutions by means of an acid. The sticking together of the fibers is only possible while this substance is present." The latter sentence is particularly true of the tendons, which Rollet also examined in the course of his investigations.

The hide also contains various other constituents (various kinds of cells, elastic fibers, etc.), but, considered from our standpoint, they only play a minor role, so that we can leave them out of sight altogether, and consider only the two principal constituents of which the hide is almost exclusively composed: 1, the *organized* portion, which consists of the glue giving fibrils with the bundles (fibers) which they form; and 2, the *unorganized* constituent, which consists of the albuminoid substance. I will here give in brief what Reimer says about these two bodies.

If hide is treated with lime or baryta water, the intermediate substance is dissolved and can be precipitated by neutralizing with acid, in the form of finely divided flakes; if this liquid is filtered, the precipitate is obtained in the form of a grayish, white, adhesive mass, which, on drying, becomes brittle and horny.

The elementary analysis gave the composition, $C_{36}H_{56}N_{10}O_{13}$*. Reimer gave this compound the name coriin. In addition to Ca and Ba water, most salts of the alkalies and alkaline earths are capable of dissolving coriin; common salt shows the peculiarity of dissolving it in ten per cent. solution, while it does not dissolve it when either more concentrated or more diluted. The caustic alkalies also dissolve coriin, but they attack the fiber at the same time.

Coriin cannot be converted into glue by any amount of boiling with water.

If to the solution of coriin in lime water or salt solution, tannin be added, it separates in the form of a coherent precipitate, the separation being more difficult as the solution is more alkiline.

The substance of the fibrils is insoluble in the above liquids, but dissolves in acids; if hide is treated for some time with dilute acids, and then neutralized, a precipitate is obtained, which in its exterior appearance is similar to the above, but has different properties. The composition, according to Reimer, is $C_{36}H_{56}N_{10}O_{15}$,† and is called *fibroin*.

Fibroin, on boiling with H_2O, is completely changed into glue.

With tannin, it behaves like coriin.

$Fe_2(SO_4)_3$ precipitates both coriin and fibroin; but here we have the essential difference, that the precipitation with tannin takes place the more readily the more alkaline the solution.

This is the most important part of what we know about the chemistry of the principal constituents of the hide.

It is perhaps admissible to doubt whether these two bodies exist in the hide in the same composition, as we get them by precipitating from solutions.

In the case of coriin, it appears as if it formed its properties by the treatment of lime water, and therefore we do not have before us the original intermediate substance, but a body the properties of which have been modified somewhat by the solution of lime water. This remark is not idle; on the contrary, I am led to believe, from many phenomena, which will be described further on, that this substance in its original properties, is much more like soluble albumen and does not differ so much from it, as the coriin obtain by precipitating from the lime water solution.

Reimer, in the above quoted article, says that the hide was not treated with lime water until after the albumen had all been removed by thoroughly washing with water, *i. e.*, until the wash water no longer gave a precipitate with ferrocyanide of potash (albumen is precipitated by ferrocyanide, while coriin is not?). But with such a complicated organism as the animal skin, with its innumerable and infinitely small interstices, which are not empty, but filled with the intermediate substance of various consistency, the thorough washing out of any body may not take place so smoothly and completely. This is also proved by the fact that the so-called coriin cannot be removed by extracting ten or even twenty times, but that by placing the hide into lime water, it will always give up further quantities of this substance. This difficulty of completely removing any body from hide can best be shown by impregnating it with any substance which has only a slight affinity for it, for instance, litmus dissolved in water. This solution rapidly penetrates the hide and colors it in its whole thickness, but it is impossible to completely extract this coloring matter again with water (no matter how often repeated), so as to bring the hide back to its original state; the hide will be destroyed first, and yet the coloring matter only adheres sufficiently to the fibers, as is shown by the fact that it is not capable of changing the properties in the least, for the skin which is saturated with the coloring matter remains in its original crude state, is just as liable to decay, and on drying becomes as hard as horn. Other substances behave in a similar manner with the hide, not taking into consideration those which have a greater affinity for the hide, such as some mineral salts and tannin.

Now it is to be supposed that the albumen contained in the hide will show a greater resistance toward solvents, because it belongs to the organism of the skin, and the solvent must first overcome the resistance with the adhesive force existing between the principal constituents. If, therefore, pure water extracts little or no albumen from the skin, this need not be evidence that there is no more contained in the skin; on the contrary, it may be present as a mixture, or in combination with some other substance (which may be similar to coriin), and fill the interstices between the fibers.

This is not only theoretically so, but is supported by a very important fact, which will be given below.

My object here was to give the reader as clear as possible a view of the constitution of the raw hide, and for this purpose I did not think it was necessary to treat of those anatomic formations which only occur in inconsiderable quantity; it is sufficient to bear in mind that the mass of the hide consists essentially of fibers, which in turn are made up of microscopic constituents, the fibrils and the interstices between which are filled with an albuminoid substance, which in different places have a various consistency. Bearing this in view, we have a picture which closely approximates the truth, and I will hold to this in my further considerations.

Since in the foregoing I considered the hide only in its unhairy and fleshing state, as it lies before the tanner, I do not consider it superfluous to make a few more remarks about the hide, as it is on the animal or in the freshly stripped state; the more so, as in the different text books, etc., on tanning, very confusing and antagonistic statements are made.

The skin, as it is taken from the animal, consists anatomically of three principal layers: 1, the upper skin, or epidermis; 2, the leather skin, or corium; 3, the cellular tissue.

It is the corium which is especially interesting to the tanner—it is this which I have above described.

The cellular tissue by fleshing is more or less removed, and consists of the same elements as the corium; but it is traversed by numerous blood vessels and lymph vessels, which partly branch off into the corium ("veins" on the *flesh* side of finished leather); there is no distinct line of demarkation between the corium and the cellular tissue.

The epidermis consists of an exceedingly thin layer of cells; the cavities in which the hairs sit are also lined with these cells; the cells are cemented together by a substance which varies from that between the fibers of the corium, the former being more readily soluble in chemical reagents. If the hide, in its raw state, is treated with such an agent, for instance, lime, acid, etc., the intercellular substance is dissolved, the cells lose their connection, as do also the hair, and both can be readily removed from the corium by fleshing with a blunt instrument.

The tanner rarely gets sight of the epidermis, or, at least, he takes no notice of it, because it is removed simultaneously with the hair, and the exceedingly delicate layer, which loses all connection, disappears in the mass of the hair.

I would further call attention to the fact that many confound the epidermis which is removed in the depilating process, with the so-called rete mucosum; but this is, as we have seen, altogether wrong, for the rete mucosum does not consist of cells, as we have seen, but of an exceedingly fine texture of fiber elements (fibrils) which rise from the corium; this is the reason why there is no defined limit between the rete mucosum and the corium.

II. BEHAVIOR OF THE HIDE WITH WATER.

The peculiar anatomical structure of the hide produces such conditions that a consideration of the chemical properties only would be very insufficient, for the physical properties play such a very important part that the chemical are altogether driven into the background. It is only necessary to illustrate this statement by an example: dissolved skin-substance is instantly precipitated by tannin, when the latter is added in sufficient quantity; that is to say, there is an immediate saturation of one by the other; the organized skin can only be saturated in the course of months, or even years; we see from this that not only does the chemical affinity play an important part, but that also the physical side must attract the most complete attention of the investigator.

As the water is the vehicle for all those bodies which are to be removed from or introduced into the hide, it is proper that we begin our observations with the behavior of the hide toward water, chemically pure as well as natural, in the condition in which it is almost exclusively employed in practice.

Some time ago it struck me that the law of capillarity played no unimportant part in the treatment of the hide with liquids, and I will give my ideas regarding this subject.

If a very narrow glass tube, open at both ends, is dipped into a vessel containing water, we will find that the water stands at a higher level in the tube than in the outer vessel; if, however, the same tube is dipped into mercury, or if the inner surface is greased, and then placed into water, we will notice that now the liquid is lower in the tube than the level of the outer liquid. These and other related phenomena are known as capillarity.

The principal laws of capillarity are the following:

1. The height of a column of liquid raised in a capillary tube, multiplied by its diameter, gives for the same liquid a constant; the height is inversely as the diameter

2. This constant varies for each liquid, and is also dependent on other circumstances.

3. Of all liquids which have been thus far examined, water has the greater capillarity; but this is reduced by any body in solution.

Of the conditions which influence the constant of capillarity, we will first consider the temperature, for which we have the law that the length of the column decreases with the temperature. This decrease is uniform for each degree in temperature, but varies for the different liquids. In the following table are given the specific gravities of a few substances at 0°; in the next column, under H mm. = height in millimeters, is given at the left the constant of capillarity at 0° in a tube 2 mm. wide; the figure at the left, multiplied by the number of degrees above zero, gives the number of millimeters which are to be subtracted from constant of capillarity, in order to find the height of the liquid at a given temperature:

	Sp. gr. at 0°.	H mm.
Water	1·0000	15·332—0·0286
Ether	0·7370	5·400—0·0254
Olive oil	0·9150	7·461—0·0105
Alcohol	0·8208	6·05 —0·0116
H_2SO_4	1·840	8·40 —0·0153

For a better understanding of this table I will give an example. If a tube, having a diameter of 2 mm. is dipped into distilled water at 0°, the water will rise 15·332 mm. in the tube (if a tube 1 mm. in diameter be used, it will *rise* under the same conditions, 30·664 mm.); if the temperature of the water is raised up to 10°, for instance, then with a tube 2 mm. wide, the water will rise only 15·332—(0·0286×10)=15·046 mm., etc.

[*To be continued.*]

* According to this formula, the composition is C_{36}=45·57 per cent. carbon; H_{56}=5·33 per cent. hydrogen; N_{10}=17·72 per cent. nitrogen; and O_{13}=30·38 per cent. oxygen.

† The substance of the fibrils, according to this formula, consists of C_{36}=48·77 per cent. carbon; H_{56}=6·24 per cent. hydrogen; N_{10}=18·97 per cent. nitrogen; and O_{15}=26·02 per cent. oxygen.

ON THE MANUFACTURE OF SUGAR FROM MAIZE.

By R. H. Harland, F.C.S., F.I.C.

The development of this industry has of late years taken rapid strides, the manufactured article having come into use mainly, in this country, for brewing purposes. In America this class of sugar is largely in demand, and is used most extensively for mixing with cane sugar and cane sirups, whereby the sweetening power of the former is considerably reduced, but a sugar is produced of a much whiter and pleasanter appearance, which commends itself to the consumer.

By far the larger portion of solid grape sugar imported into this country comes from America, but up to the present time its consumption has been restricted to the brewer, and more recently for confectionery and preserving purposes. The quantities imported during the last few years are as follows:

1879	317,763 cwts.
1880	405,760 "
1881	399,648 "

This proves that its use is widely extending, and although the figures do not show such a marked increase as might perhaps have been expected, yet the imports of the present year will probably be far in excess of any previous quantity.

In the colonies this article is already attracting attention, and the time is, probably, not far distant when the districts suitable for the cultivation of maize and other starchy plants will be turned to account for the production of glucose and spirit.

In England there are several manufactories turning out a considerable quantity of liquid glucose (and I may here mention that the term glucose, or grape sugar, is applied to both the liquid and solid article, although, as will presently be shown, they differ materially in composition), but up to the present English manufacturers have been unable to produce an article equal to American, and this is, no doubt, due to the greater demand for the substance in America, which has caused a greater amount of attention to be directed to this industry.

In the manufacture of grape sugar a grain is selected which is rich in starch, and, for this reason, it is the starch which is converted into sugar; so that the larger the percentage of starch the greater is the yield of sugar, providing always that nothing is present in the grain which will cause loss of sugar or deterioration of the product during the operations incidental to its manufacture.

Starch is one of the most widely disseminated substances in the vegetable world. It is contained in the root, bulbs, leaves, bark, blossoms, fruit, and seeds of the most varied species of plants in various proportions, in some cases amounting to within ten to twenty per cent. of the entire weight of the plant. Of course, the quantity of starch varies with the species of plant, the country in which it is grown, and also the mode of treatment during cultivation. The following table will give an idea of the proportion contained in various species of corn and grain:

	Starch.	Moisture.	Oil.	Albuminoids.	Gum, Sugar, etc.	Cellulose.	Ash.	Nitrogen.
Wheat	63·30	14·50	1·90	14·40	—	4·20	1·70	—
Saigon rice	77 07	12·54	0·64	7·86	1·00	0·28	0·61	1·17
European maize	76·48	12·35	1·58	8·05	—	1·08	0·46	1·28
White American maize	71·41	11·88	4·19	7·00	—	4·16	1·36	1·12
Red American maize	74·91	12·05	2·09	5·69	—	4·00	1·26	6·91
Potatoes	20·0	76·00	—	—	—	—	—	—

Starch belongs to that class of neutral bodies which are termed carbohydrates; its composition is expressed by the formula $C_6H_{10}O_5$ in common with dextrine, cellulose, and other allied bodies which, on being submitted to ultimate analysis, are shown to contain exactly the same number of equivalents of carbon, hydrogen, and oxygen, so that the formula $C_6H_{10}O_5$ represents the composition of the class of carbohydrates which includes substances differing materially in appearance and physical properties. Starch is insoluble in cold water, but on being heated with water to a temperature of 60° C. it gelatinizes, and if sufficiently strong is transformed into a jelly or stiff paste; the same result takes place at higher temperatures, the starch granules bursting and dissolving in water.

On heating starch to a temperature of 200° C., it is gradually transformed into soluble starch and dextrine.

On boiling with dilute acids—hydrochloric or sulphuric—dextrine and maltose are formed, which by prolonged boiling are converted into dextrose. It is on this reaction that the manufacture of dextrose or starch sugar is founded. Represented by chemical equation the action is:

Starch.		Water.		Maltose.		Dextrine.
$3C_6H_{10}O_5$	+	OH_2	=	$C_{12}H_{22}O_{11}$	+	$C_6H_{10}O_5$.

After the lapse of some time and continued heating, the dextrine is entirely converted into dextrose.

The part which the acid plays in this reaction is not thoroughly understood; it causes the starch, however, to combine with the necessary quantity of water for its conversion into sugar, remaining unacted upon itself.

Maltose, an isomer of cane sugar, is probably identical with the sugar produced by the action of malt extract on soluble starch, and is always present in properly prepared brewer's worts.

Starch may also be converted into sugar by the action of diastase, a peculiar substance contained in malt. This operation is carried on by the brewer in the preparation of malt worts, and the action of the diastase on the starch of the grain is, according to the researches of Payen and others, to first convert two-thirds into maltose, and the remaining one-third into dextrose, the maltose undergoing gradual transformation into dextrose, as the dextrose is converted into alcohol and carbonic acid by the action of the ferment.

Conversion of Starch into Sugar.—It is well known that by the action of acids on starch, substances are formed varying in character and composition with the time during which the action of the acid is allowed to take in a boiling solution. In the preparation of glucose on a manufacturing scale, it is not unusual to employ pressure and an excess of acid over and above the quantity necessary for converting the starch, in order to accelerate the formation of dextrose; numerous patents have been taken out for machinery in order to either more rapidly effect the conversion or to subject the grain after mixing with water to a considerable temperature, and pressure in closed vessels, previous to the treatment with acid; but in all cases the whole grain is treated, and the matters left undissolved by the acid are removed by filtration at a subsequent stage.

The quality of the article produced depends in great measure upon the quantity of acid used and the time allowed for the operation. To produce a white starch sugar it is necessary to prolong the treatment until all the dextrine has disappeared, and the resulting solution of sugar is refined with animal charcoal previous to concentration. When a liquid glucose is required, the presence of the dextrine is necessary to preserve the substances in a liquid form, as otherwise partial solidification would result from the dextrose crystallizing out.

In America, where large quantities of grain are continually being converted into sugar, the best results both as to quality and price are obtained by first subjecting the grain—generally maize—to a process for the removal of the greater part of the oil and albuminoid materials. This is readily effected by first steeping in cold water for some hours, cracking it either in a disintegrator or between millstones, and delivering the broken-up maize with water into a centrifugal machine provided with a number of steel beaters revolving in a reverse direction to the machine. This effectually removes the greater part of the starch which is carried away suspended in the water and afterward allowed to settle out on suitable starch tables. The germ, containing a large proportion of oil and albuminoids, together with the greater proportion of the outer skin or rind, is retained in the machine, while the portion which finds its way through with the starch can be readily removed during the process of settlement or by sieves. The starch thus produced is stirred with water to a milk and run slowly into a vat containing boiling dilute sulphuric acid varying in strength from 1 to 5 per cent. The boiling is continued until the whole of the starch is converted into sugar; the time of course varies greatly with the strength of the acid and the quality of the sugar required to be made, but with open converters it is necessary to boil for from four to eight hours, using 2 per cent. acid. It is essential to keep the concentration of the liquid as great as possible so long as the formation of sugar is not impeded, in order to avoid the cost of evaporation. The liquid is carefully neutralized and the resulting precipitated calcium sulphate removed by filtering under pressure from a monte-jus or pump, through a filter press. When solid sugar or dextrose is being manufactured the liquid will have a density of from 22° to 27° B., and contain from 4·5 to 5·5 lb. dextrose per gallon; it requires refining by means of animal charcoal, exactly in a similar way to cane sugar, and afterward concentrating in a vacuum pan.

In the treatment of the whole grain a similar plan is adopted, preference being given to shortening the time of conversion by increasing the pressure on the surface of the boiling liquor to 90 lb. or thereabouts on the square inch, the liquor being neutralized with chalk and the calcium sulphate together with the undecomposed portions of the grain removed by filtration. There are decided objections to be urged against this method, which do not apply with equal force when the American mode of manufacture by first removing the impurities is employed.

The valuable nitrogenous portions of the grain are so admixed with calcium sulphate as to render what would otherwise be a valuable feeding material for cattle almost worthless, whereas—as is shown by the following analysis—the American residue contains all the feeding qualities of the grain in a fairly concentrated form.

	Residue when whole Grain is treated.	Residue when Starch is treated.
Moisture	9·00	10·86
Oil	10·00	6·09
*Albuminoids	20·30	13·60
Uncrystallizable sugar	7·10	—
Starch, mucilage, etc.	—	54·54
Mucilage, etc.	18·50	—
Cellulose	6·80	14·04
Ash	28·30	0·78
	100·00	100·00
* Containing nitrogen	3·25%	2·19%

Further, it is well known that various organic combinations are formed by the action of the acid on the oily and non-starchy portions of the grain, which not unfrequently impart to the sugar an unpleasant taste and smell, requiring an increased quantity of animal charcoal to remove and absorb them—in fact, it is doubtful whether they are ever entirely removed, but probably small traces remain to the detriment of the finished article, and may be the cause of unsuccessful fermentations when used for brewing, and if required for the manufacture and distillation of alcohol would produce a spirit inferior in flavor to that obtained from sugar prepared from nearly pure starch. It is therefore questionable whether the superior quality of the sugar and the higher value of the residue as cattle food does not more than compensate for the increased cost—about 13s. per ton on the raw grain—in removing the albuminoid substances, and the loss of starch in the food which would otherwise have probably been converted into sugar.—*The Analyst.*

ANTHRACENE FROM BAKU PETROLEUM.

The manufacture of anthracene from the natural oil streams at Baku, in the Caucasus, is likely soon to exert an influence on the price obtained for that exported from England and other older centers of the tar-distilling industry. It is said that there are more than a hundred distinct wells in the Caucasus, within an area of about 2,000 acres; one of them giving a jet of oil 21 centimeters (8·2 inches) in diameter, thrown to a height of 36 meters (118 feet), while another well gives a daily yield of 112 tons. According to Professor Roscoe, writing in a recent number of the *Journal of the Society of Chemical Industry*, the process of manufacturing anthracene from this petroleum depends upon the fact, observed by Letny, that the tarry residues obtained in the process of gas making from petroleum, resemble ordinary gas tar in containing aromatic compounds, such as phenol and anthracene. The same fact was also observed by Liebermann and Burg, who were successful in transforming the constituents of brown coal tar (chiefly consisting of the paraffin series) into aromatic hydrocarbons, by passing the vapors through red-hot tubes filled with porous material; the result of this operation being to obtain a tar almost identical in composition with ordinary coal tar containing about 4 per cent. of benzene and toluene, and 0·9 per cent. of crude anthracene. The application of this principle to the artificial production of anthracene from Baku petroleum is now an accomplished fact; the following details being supplied by Professor Liebermann: Messrs. Nobel Brothers, of Baku, last year experimented on a large scale with these results: 800 tons of those portions of the kerosene boiling above 270°, and having a specific gravity of 0·835 to 0·885, was the material employed for the purpose of gas making; 1 kilo (2·2 lb.) yielding from 0·5 to 0·6 cubic meter (17·6 to 21·1 cubic feet) of gas, and 30 per cent. of tar; while the latter material gave 6 per cent. of pure benzene and toluene, and 0·6 per cent. of anthracene. Messrs. Nobel propose to work next year on a much larger scale, and submit 20,000 tons to dry distillation. This should yield about 40 tons of crude anthracene, and 1,000 tons of crude benzene.

THE INNER CONSTITUTION OF MATTER.

The following is an abstract from Prof. G. D. Liveing's recent address before the Chemical Section of the British Association:

A few years ago, Mr. Lockyer supposed that the coincidence of rays emitted by different chemical elements, particularly when those rays were developed in the spark of a powerful induction coil, and in the high temperatures of the sun and stars, gave evidence of a common element in the composition of the metals which produced the coincident rays. Such an argument could not be drawn from the coincidences unless they were exact, and the identity of the lines could only be tested by means of spectroscopes of great resolving power. By the use of the well-known Rutherfurd gratings, Young in America had found that most of the solar lines which had been ascribed to two metals were in reality double, and Dewar and I, working on the terrestrial elements in the electric arc, had found the actual coincidences to be very few indeed. These observations, even with Rutherfurd gratings, were delicate enough; but quite recently M. Fievez, of the Brussels Observatory, has brought to bear on this question a spectroscope of unexampled power. By combining two of the Astronomer Royal's highly dispersive half-prisms with a Rutherfurd grating of 17,296 lines to the inch, he has obtained a dispersion quadruple that of Thollon's combination of prisms. Bringing this to bear on the sun he has mapped the solar spectrum from a little below C to somewhere above F, on a scale one third greater than that of Vogel's map, and has not only confirmed the work of Young, Dewar, and myself, but has resolved some lines which were not divisible by such dispersive power as we had at command. This result cannot fail to shake our belief, if we had any, in the existence of any common constituent of the chemical elements; but it does not touch the evidence which the spectroscope affords us, that many of our elements, in the state in which we know them, must have a very complex molecular stricture. I cannot illustrate this point better than by the spectra of two of our commonest elements, magnesium and iron. We have good reason to think the molecule of magnesium to be as simple as that of any chemical element, and we find its spectrum to be one of the simplest, consisting of a series of triplets which repeat each other in a regular way and are probably harmonically related, and of a comparatively small number of single lines, of which also some may be harmonics. The spectrum of iron, on the other hand, presents thousands of lines distributed irregularly through the whole length, not only of the visible, but of the ultra-violet region. Make what allowance you please for unknown harmonic relations, and for lines which are not reversible and may not be directly due to vibrations of the molecules, we still have a number of immense vibrations, so that we can hardly conceive any single molecule to be capable of all of them, and are almost driven to ascribe them to a mixture of differing molecules, though we have as yet no independent evidence of this, and no satisfactory proof that any of this mixture are of the same kind as occur in other elements.

M. Fievez's combination is a great advance in resolving power, but Professor Rowland, of the Johns Hopkins University, promises us gratings not only exceeding Rutherfurd's both in dimensions and accuracy of ruling, but ruled upon curved surfaces so as to dispense with the use of telescopes, and avoid all variations in focusing the different orders of spectra. His instruments, if they come up to the promise he holds out, will enable us to solve many questions which are difficult to answer with our present appliances.

But to return to the chemical elements: the spectroscope has in the last few years revealed to us several new metals. I will not venture to say how many, for when several new metals more or less closely allied are discovered at the same time, the process of sifting out their differences is necessarily a slow one. We cannot tell yet whether any of them are to fill gaps in Mendelejeff's table, and so add strength to the conviction that there is a natural relation between the atomic weights and the chemical characters of our elementary substances, or whether they will add to the embarrassment in which we already find ourselves with regard to the relations of the cerium group of metals; whether we may welcome them as the supporters of order, or deprecate their coming as authors of confusion. Granting that the chemical characters of an element are connected with its atomic weight, we have, however, no right to assume them to be dependent on that factor alone. Why may there not be elements, which, while they differ as little in atomic weight as do nickel and cobalt, are, on the other hand, so similar to one another in all characters that their chemical separation is a matter of the greatest difficulty, and their difference only distinguishable by the spectroscope? The spectra may be thought to suggest so much, and how shall we decide the question? At any rate the complications of the spectroscopic problem can only be unraveled by the united efforts of the chemists and physicists, and by the exercise of extreme caution.

Dr. Siemens explains the self-luminous character of comets by the theory that the streams of meteoric stones of which they are supposed to consist, bring from stellar space hydrocarbon and other gases occluded within them, and that in consequence of the rise of temperature due to the frictional resistance of such a divided mass moving with enormous velocity, aided by attractive condensation, the occluded gases will be driven out and burnt, the flame giving rise to the original light emitted by the nucleus. Now the spectrum of most comets shows only the principal bands of a Bunsen burner, and is therefore adequately explained by the flame of gas containing hydrocarbons such as have been found in meteorites; but Dr. Huggins has observed in the spectrum of more than one comet not only hydrocarbon, but cyanogen bands; and, although carbon and nitrogen combine readily in the electric arc, a coal-gas flame in air shows no trace of the spectrum of cyanogen, and it would certainly put some strain on our credulity if it were asserted that cyanogen was one of the gases brought ready-formed by meteorites

from stellar space. Dewar and I have, however, recently shown that if nitrogen already in combination, as, for instance, ammonia, be brought into a hydrocarbon flame, cyanogen is produced in sufficient amount to give in a photograph (though not so as to be directly visible) the characteristic spectrum of cyanogen as it appears in the comet. It is therefore no longer necessary to make any other supposition to account for the cyanogen bands in the spectra of comets, than that ammonia, or some such compound of nitrogen, is present as well as hydrocarbons in a state of ignition.

Quite recently Dr. Huggins had observed that the principal comet of this year has a spectrum of an entirely different character, but he is not yet able to say to what elements or compounds it is probably due. The notion that comets may bring us news of distant parts of stellar space, toward which our system is driving, where the atmosphere is not like ours—oxygen and nitrogen—but hydrogen and hydrocarbons, may fascinate the fancy, but the laws of occlusion oblige us to think that the meteorites have not merely wandered through an attenuated atmosphere of hydrogen and hydrocarbons, but have cooled in a much denser atmosphere of those substances, which we can only conceive as concentrated by the presence of a star or some large aggregation of matter. They may, perchance, have come from some nebulous mass, for Draper and Huggins tell us that in the great nebula in Orion hydrogen is dense enough and hot enough to show some of its characteristic lines, besides the F line which is seen in other nebulæ, and is the last to disappear by reduction of density. No comet on visiting our system a second time can repeat the exclusion of its occluded gases unless its store has been replenished in the interval, and it will be interesting to see, when Halley's comet next returns, whether it shines only by reflected light, or gives us, like so many others, the banded spectrum of hydrocarbons.

A BISMUTHIC HAIR DYE.*

By A. NAQUET.

THE author states that he was induced by a knowledge of the injurious properties of the many hair dies that are put forward as perfectly harmless to make the attempt to produce one that should be fairly entitled to that description. While working upon the subject he protected the different steps by patents, in order to secure priority, but having attained what he considers to be a satisfactory result he has now abandoned his rights for the public benefit.

M. Naquet's experiments were made in the direction of compounding a metallic tincture that should have an inoccuous metal for a basis instead of lead, and for this purpose he selected bismuth. The preparation which was the subject of his first patent consisted of two solutions that were mixed immediately before being used, and he describes the method of making it as follows:

It has long been known that a solution of bismuth is obtained in treating bismuthic hydrate with a solution of bitartrate of sodium; but it is not very easy to prepare and not more than a very small proportion of the bismuthic hydrate employed is ever dissolved. M. Naquet therefore sought an easy method of preparing the double tartrate of potassium (or sodium) and bismuthyl ($C_4H_4NaBiO_6$). The bismuth is dissolved in the smallest possible quantity of nitric acid, and to this is added an aqueous solution of tartaric acid (3 parts of acid to 5 of bismuth) and a large quantity of water; the whole is then thrown on a filter and the precipitate washed. The wash water contains some bismuth, which can be removed by precipitating with a sulphide, then redissolved in nitric acid and used in a subsequent operation. The well washed precipitate, while still moist, is dissolved in a boiling solution of sodic bitartrate (12 to 15 parts of bitartrate to 5 of bismuth), then filtered, diluted with water, alcohol, and glycerine, and again filtered. Each liter should contain 150 c. c. of glycerine, 150 c. c. of alcohol and 600 c. c. of water. The proportion of bismuth present should be 2 grammes of metal per 1,000, and if the liquor contains more or less it should be brought to that strength. The paper through which this liquid is filtered will retain some bismuth, precipitated by the alcohol; this can be redissolved in nitric acid and again used.

The bismuthic solution alone does not dye, but mixed with sodium hyposulphite it soon deposits sulphide of bismuth, which dyes the beard and hair. But as this mixture is quickly decomposed it must not be made until just as it is going to be used. This form of bismuthic hair-dye, therefore, requires to be sent out in two bottles, one containing the bismuthic solution, the other the solution of sodium hyposulphite (1 part of solution saturated in the cold diluted with five parts of water). When required for use these are mixed together in equal proportions.

The bismuthic product precipitated by tartaric acid and water can be dissolved by means of carbonate of potash, or by any of the caustic or carbonated alkalies, including ammonia, the liquid being after neutralized by a current of carbonic acid gas and filtered. But unfortunately this neutral product, or even one slightly alkaline, does not act as a dye when mixed with either hyposulphite of soda or flowers of sulphur. It can only be used by moistening the hair first with the bismuthic liquid, and then, after it has dried, with a solution of sulphydric acid or a sulphide.

This dye is said to have a progressive action, and to produce all the shades from a light flaxen to a deep chestnut color, according to the number of applications made.

The second patent was taken out for a preparation that could be sent out in one bottle. M. Naquet while pursuing his investigation, having found that an ammoniacal solution of the tartrobismuthic product will keep indefinitely when mixed with solution of hyposulphite of soda, if the containing bottle be kept well closed. Such a mixture is said to make an admirable hair-dye, it decomposing and depositing sulphide of bismuth in proportion as it loses ammonia and is acted upon by carbonic acid in the atmosphere. The degree of concentration of the liquid is not of great importance, nor the quantity of ammonia. The following is the working formula given by M. Naquet:

Dissolve 100 parts of bismuth in the smallest possible quantity of ordinary nitric acid (about 280 parts). To this liquor add a solution of 75 parts of tartaric acid in water, and then a rather considerable quantity of water to insure complete precipitation. The whole is then thrown upon a filter and the residue washed with water until the washings are no longer acid. The magma left on the filter is then put into a dish and solution of ammonia gradually stirred in until all is dissolved. The magma derived from 1½ kilogrammes of bismuth will require 0·8 or 0·9 liter of ammonia. To this liquor is added 75 parts of hyposulphite of soda in powder, and when the salt is dissolved the product is filtered and put into bottles. In this state it is ready for sending into commerce, but it is of advantage to add 1 or 2 per cent. of glycerine; no addition of alcohol is necessary. The liquid so prepared would contain about 5 per cent. of bismuth. It may be further diluted with water if desired.

The hair or beard when saturated with this liquid acquires after five or six hours a deep chestnut color. Upon washing the hair this color disappears, giving place to a delicate flaxen color. By repeating the operation daily a stage is arrived at when, after passing through all the intermediate shades, the deep chestnut color remains persistent.

* Abstract from communication to the *Moniteur Scientifique*.

MILK SICKNESS AND THE VOLATILE METALS.

To the Editor of the Scientific American:

Referring to the volatile metals in milk sickness, I would not like to have selenium overlooked. This is one of the gas metals as well as arsenic, and in its poisonous effects I think fully as bad as arsenic. When its fumes are inhaled the sting of mad itch in spots about the face and nostrils, the sense of constriction through the nasal passage and throat, and the intense aching across the breast in the lungs are felt from the start: but I usually find it and arsenic together in all the waters and persons and cows affected with milk sickness that I have examined; and both working together are capable of creating great sufferings among the human family. Experience has convinced me that selenium plays a part that I at the first attributed to sulphur, as to sharpen the teeth, cause the nose to run, etc. It appears to have the power to corrode, and may be the cause of all cancers for aught I know. But my object is to get scientific men and physicians to help me clean milk sickness clear out of the country. And now while I write this I hope some long-headed genius, perhaps a Yankee, is figuring out some cheap process by which he can chemically neutralize all of these poisonous gas metals in any bucket of water without injuring the taste and value of the water. Possibly charcoal will be employed in some good way. Zell says that carbon will absorb gases, and the more poisonous the gas the greater the quantity absorbed. I can prove them to be gas and metal, and have very good reason to think that selenium is some of the sulphur gases held in contact with copper till it is copperized gas, which, when it is finished, will some day be copper itself: as when the dentist combines his elastic India-rubber with sulphur heated till its nature is changed into a fixed substance called vulcanized rubber. It has the tarnish of copper, and in a closed tube yields a metal greatly resembling copper. Experimenting with the matter I find it in the wells, cisterns, cows' milk and clouds all alike, and made a few analyses, a few of which I give you. I took some of the urine of parties that had seen hard times by reason of milk sickness and precipitated with hydrochloric acid; the precipitate in the open tube yielded bright white crystals of arsenious acid and a steel gray sublimate of selenious acid. The arsenious acid began to deposit a little first and took its position a little above the selenious acid, showing that arsenic is a little more volatile than selenium. The odor of garlic was there. The amount of metals obtained was alarming in the extreme—about equally divided. A few other cases of urine were examined with about the same result. I took some water from the well of a family that had had a good deal of milk sickness, and precipitated with lye. The precipitate in a closed tube yielded a large amount of crystals of arsenic with selenium, probably about a grain per two or three quarts. In the same water I moistened a cotton wad, and wiping the wad across a clear pane of glass I painted a stripe in bright colors of red, blue, yellow, and green, viewed by reflected light at an angle of 45 degrees (selenic acid and arsenic acid).

Analyzed the breath of a man I know had milk sickness more than twenty years and trembled all the while. He exhaled about eight long breaths in an open tube, then both ends of the tube were closed and the contents, which was water, poured down into one end and heated over a lamp flame till vaporized. I drove the sublimate back and forward a few times to separate the crystals out from the water, and a large amount of arsenic was obtained in crystals, perhaps about one-twentieth of a grain. There was selenium with the arsenic. On a pane of glass he blew his breath till moist, and across the spot I wiped a cotton wad and made the usual spot of red, blue, green, and yellow (selenic acid and arsenic acid), which shows the use of exercise to work off these oxides through the lungs.

I boiled the milk of cows in a tin cup and poured away the contents. On the bottom of the cup I found deposited a large number of minute semi-transparent octahedral and rhombic crystals. In a closed tube I put a few crystals, and heating it over a lamp flame a portion sublimed, carrying with it grease and water. I drove the sublimate back and forward a few times to separate the crystals out and obtained crystals of arsenic and a large amount of arsenic and selenium alloyed together in crystals having copper red shades. The crystals were of the shape set forth in Louis Olivier's Figs., Nos. 1 and 3, in SCI. AM., No. 13, Sept. 23, page 199. The odor of garlic was there. These cows were in apparent good condition in a good pasture, only they were in a milk sickness country, where selenides and arsenides abound. I analyzed the clouds by setting an open crock, made clean by boiling, on a platform in open space when beginning to rain, and in a glass tube, both ends closed, heated some of the water caught till vapors arose and deposited along the walls of the tube. I drove the deposit back and forward a few times to separate the volatile metals out from the water, and got bright crystals of arsenic, also selenium, besides there was a large amount of arsenic and selenium alloyed together. The garlic odor of arsenic was strong. The clouds were half a mile high and coming from the west, and might have brought its load from the western side of the continent, where arsenides and selenides of copper abound. They were taken up by the heat of the sun in vapors, and furnish an item for those who drink and cook with cistern water to get it pure. In winter probably no metals could be obtained. I took walks along ditches and streams intersecting veins of copper and other ores when nearly dry, and saw here and there films of arsenious acid and black oxide of copper leaching out of the ground in the water's edge resembling a solution of chalk floating upon a bed of ink. In other places were films of selenic and arsenic acid floating on the water and mucky ground in bright colors of red, blue, green, and yellow. All of these and more, and yet the courts in a *post-mortem* examination regard the presence of arsenic as evidence of a suicide or homicide.

In the SCIENTIFIC AMERICAN I now and then see where parties are dealing with the volatile metals for live animalcules in blood or in water, and of which I would not speak, but for the advancement of science. One case in particular: Louis Olivier, in *La Nature* (SCI. AM., No. 13, Sept. 23), has, strange enough, been treating arsenic and selenium under a 530 diameter microscope for animalcules. It is equally strange that he has to resort to Paris violet to see their form when he has so powerful a lens, when I can see them perfectly with the naked eye! He thinks he cultivates them and kills them with osmic acid and gathers their dead carcasses to examine them with a microscope, when really they have no life, but are actuated by gas, and though I would like to know what osmic acid does to them, I can only kill them by freezing them to death; but they come to life again as soon as they are warmed to about 50° F., and the warmer you make them the faster they move and multiply. The fact of it is these are gas metals, the same as gas balloons. Their tendency to split up when arsenic is present in the water and give off crystals from the alloy, the activity with which they move and multiply when warm enough, their extremely small size and great numbers packed into a small drop of water, and their great transparency when in the metallic state, all rendering them hard to see, has misled some of the very best men we have. Mr. Olivier's drawings are all very good ones, and to exhibit the picture which I am about to draw I will refer you to his full set on page 199 of SCI. AM., No. 13, Sept. 23. They all have tails, only one for each. The apparatus I have invented for their examination as a study is this: Take rain water that contains selenium and arsenic in solution—probably all rain water has in hot weather; heat it in a basin to not below blood heat. Put in soap enough to make a suds. Now between your thumb and forefinger take on a web or film of soap suds and arrange it in a circular form, keeping the ends of the thumb and forefinger together. Now hold it up opposite your eyes and elevate one edge of the film and view it by reflected light. View it at an angle of 45 degrees to the right or left, and you have now before your eyes the grandest picture ever the human eye beheld—a lake clear as crystal and smoother than glass, upon the face of which the least coloring can be seen. The metal at first is at the foot of the lake in the dissolved metallic state, perfectly transparent, and yet we can see it without color; but before we have got the sheet fairly drawn it is all alive in active motion; the whole web shakes—they are giving off and sending up crystals by the wholesale, which can only be seen by the wave, but an instant more and they are away up toward the middle of the web or film, and have consumed enough oxygen from the warm air to corrode and color them all in beautiful colors of bright red, blue, yellow, and green, with every possible change of blending of the same. They arrive at the top of the film, and having become perfectly oxidized are in the state of selenic and arsenic acid, and so pour out their coloring fluid in parallel horizontal belts of bright red, green, blue, and yellow, the same color as seen in the rainbow. The little crystals keep pouring their coloring fluid into these bright layers above as they arrive till all have passed the change or been interrupted by the commotion among the gases, and the film breaks. Now make the water hotter and take another film and hold it up quick. Before you can draw the picture they have outgone you; the whole face of the film is covered from bottom to top; they are now already colored when they start; they do not wait to let you examine each individual: they hurry up, they swim like fish—they have eyes, mouth, and tail; some have larger heads than others, with several pigment granules of selenium. Keep your eye on some one of these if you can, and see the head split, some of the pigment granules going with each piece, when each individual part will then ascend having a tail of its own—their loose, spongy, half dissolved body strings back and makes the tail. Each fish seems to have some spot, usually in the front, which is white. That is arsenic, which comes out, owing to its more volatile nature, more easily oxidized, and spreads itself all over the balance of the fish, which was red with selenium when it started, and seems to devour it up, the pigment grains of selenium being concealed within. On this film of soap what a picture! A sea of fish! A grand fleet of balloons, each having a drag rope behind! A fleet of ships all sailing under national colors! A grand display of fireworks—a sky of roman candles, at once pleasing and instructive! As when the astronomer pokes his long telescope up among the upper globes of blue and green and red and yellow, and while gazing upon the picture, half intoxicated with curiosity, frequently an explosion takes place at the head of the film and sends its fragments down toward the bottom and scattering the contents of some little world hitherward and thitherward, much after the manner of the bursting of a meteor; and for aught I know some astronomer that reads this picture will better understand that strange piece of malleable iron and nickel. But if you will excuse me now I will write you more the next time.

ELLIOT EBERLY.

Portage, Wood Co., Ohio, Oct. 7, 1882.

BLACK WALNUT LEAVES AS A REMEDY IN SCROFULOUS AND CACHECTIC AFFECTIONS.

DR. ORLANDO C. FARQUHAR, of Zanesville, O., brings to the notice of the profession the great medicinal value and curative properties possessed by the leaves of the common black walnut. He says: "I am personally cognizant of very many cures that an infusion of the leaves of the common black walnut has performed after the skill and prescriptions of many excellent physicians had signally failed. This remedy has never, to my knowledge, failed to cure or greatly benefit whenever used. That is saying a great deal for walnut leaves, and yet such is the truth; and 'facts and figures are stubborn things.' My father, Dr. E. A. Farquhar, Sr., has continuously used this remedy for the last quarter of a century. With a reputation and practice co-extensive with the boundaries of the State, he had frequent opportunities for testing the virtues of the remedy. As an alterative and depurative, possessing marked powers in the cure of all scrofulous and cachectic affections, its value has often been demonstrated. Syphilitic ulcerations and squamous diseases of the skin soon yield to the effects of an infusion of the leaves of the black walnut. Chronic ulcers of the indolent kind have been cured with this remedy, after every other remedy had been exhausted without benefit. Our plan has been to wash the parts affected, if external, two or three times daily with the infusion, and at the same time take it internally. In cases of syphilis, I often combine or add to the infusion an alcoholic solution of hydrargyrum corrosivum, with good results.

"M. Negrier, professor of the school at Angers in 1841, published an interesting memoir on the use of walnut leaves in scrofula, which he regards, after numerous experiments, as one of the best anti-scrofulous remedies that we possess. M. Negrier, as well as several other medical men at Angers, had long been in the habit of employing a decoction of walnut leaves as a lotion for scrofulous sores.

"M. Negrier concludes his memoir with the following

directions for the preparations of walnut: 'The infusion is made with an ounce of leaves to twelve ounces of boiling water. It may be sweetened with sugar or the sirup presently to be noticed. Two or three cupfuls may be given daily, or even five. The decoction is made with a handful of the leaves boiled fifteen minutes in a quart of water. The extract may be made in the usual manner from the dried leaves. For the sirup eight grains of the extract are mixed with thirty-two scruples of common sirup; infants and young children may take two or three teaspoonfuls in the day; adults three drachms. The pills may be made of the extract, four grains in each; from two to four in the day.'"

THE DIMENSIONS OF THE VISIBLE UNIVERSE.*

By PROF. E. CATALAN.

ALL persons who have some notion of geometry, or who have met a surveyor, know how we manage to find the distance from a given point, A, to an inaccessible point, B (Fig. 1).

Let us suppose, to take a simple example, that the observer, A, is separated from the signal, B, by a river. By means of a surveyor's chain he measures a rectilinear base, AC; then, with a graphometer, carried successively to A and C, he measures the angles, AC; after which, a graphic construction, or a very simple calculation, makes known the two last sides of the triangle, A B C. The distance, A B, is then determined at least as approximately as if it had been possible to stretch a line from A to B.

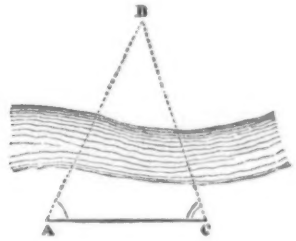


FIG. 1.

This process, which is very rudimentary, may serve to calculate the distances from the earth to the other planets—to the moon, to the sun, to the stars. Only, in order that it be effectual, the base, A C, must be *sufficiently great;* for, if too small, it will be found that the visual rays, A B, B C, instead of intersecting, will be parallel. In other words, the angle, B, will appear nul, and the star, B, will behave for us as if it were in infinity.

Before seeking to find how far the sun, for example, is from the earth, it has been necessary to measure the latter, then, in order to establish a base.

I have no need to tell you, gentlemen, that the earth is a ball, a spheroid, isolated in space. The proofs of the roundness of our planet are well known; and I will recall only the most celebrated one of all—the voyage of Magellan.

Starting from the port of San Lucar de Barrameda, at the mouth of the Guadalquivir, on the 21st of September, 1519, the illustrious navigator steered toward the southwest, and touched successively at Teneriffe, Rio de Janeiro, and the port of Saint Julien, in Patagonia. On the 21st of October, 1520, he discovered, at the point of South America, the strait which bears his name; then, coming up toward the northwest, he traversed the great ocean and arrived at the Philippine Islands, and afterward at the Marianne Islands, whence he returned to the Philippines. It was at Zebu, one of the latter, that he perished in a fight, on the 26th of April, 1521. A single vessel and a crew of eighteen men, commanded by Sebastien del Cano, continued their route toward the west and re-entered at San Lucar on the 6th of September, 1523, as if they had come from the east.

I have just said that the earth is *isolated in space.* I will remind you further that it revolves upon itself almost like a top, and that the straight line around which the rotation occurs is called the *axis of the world.* The *poles* are the points where the terrestrial surface is met by this ideal straight line. Imagine to yourselves an orange traversed by a knitting needle! To judge by appearances, the heavens revolve in their entirety around the axis of the world. This diurnal motion takes place from east to west, while, really, the earth is revolving from west to east.

Upon this apparent diurnal motion, I shall make three remarks:

1. The axis of the world always seems to pass through the place of observation.

2. The relative positions of the stars situated upon a same horizon, or, what is the same thing, their *angular distances,* are entirely independent of such place.

3. The *stars have no apparent* diameter; seen by the telescope, any star whatever is always reduced to a brilliant point.†

Not only did the ancients believe the earth immovable, but they *solidified* what we call the heavens. This latter ideal sphere, the result of a pure illusion of our senses—became for them a true vault of crystal to which the stars were attached. The following curious citation on this subject is borrowed from Arago's Popular Astronomy:

"The heavens are that which revolves continuously around the earth and sea upon an axle whose extremities are like two pivots that sustain it; for, at these two places, the power which governs nature has manufactured and put these pivots as two centers, one of which goes from the earth and sea to the top of the world, near the stars of the north, and the other is opposite, under the earth, toward the middle; and around these pivots, as around two centers, it has put little naves, like those of a wheel, upon which the heavens continually revolve."—(Vitruvius.)

I now arrive at the question which is to occupy us first:

WHAT ARE THE DIMENSIONS OF THE EARTH.

Let P E P' E' (Fig. 2) be the meridian of any place whatever, A (Liege, for example). Let P P' be the poles; E E', the equator; H H', the horizon; A Z, the vertical. If the earth is supposed to be spherical, A Z is the prolongation of the radius, O A.

Again, let A B be a parallel to the axis of the world, or, very nearly, the visual ray passing through the polar star. The angle, B A H, is what is called the *height of the pole,* and an inspection of the figure shows that it is equal to the angle, A O E', the latitude of the place, A.

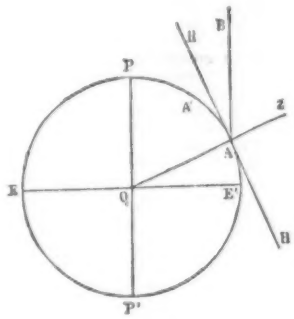


FIG. 2.

If the observer betakes himself to A', so that the height of the pole has increased by 1°, the arc, A A', will equal 1° of the meridian. Just so, when the height of the pole increases by 2° or 3°, the arc, A A', will equal 2° or 3°. Knowing the length of this arc, A A', we may easily conclude therefrom the distance, P E', from the pole to the equator, and then the radius of the earth. Everything, then, reduces itself to this problem: *to measure the arc of a meridian, knowing the difference between the latitudes of the extremities of such arc.*

One of the most ancient measurements that history mentions is attributed to the illustrious Eratosthenes, who was at once a geometer, astronomer, geographer, philosopher, grammarian, and poet. Knowing that, at Syene, in Upper Egypt, the sun rose to the zenith on the day of the summer solstice, since the largest edifices cast no shadow at noon, Eratosthenes conceived the idea of measuring, on that same day, the zenithal distance from the sun to Alexandria (or rather to Meroë, in the opinion of Vincent), which is perceptibly upon the meridian of Syene. He found for such measurement 7°20'. Moreover, the distance between the two cities was admitted to be 5,000 stadia. The result of this remarkable attempt of Eratosthenes was to fix the circumference of the earth at 252,000 stadia.

To ascertain whether this determination differs much from results obtained recently, it will be necessary to know the value of the stadium employed by Eratosthenes. According to the savant whom I have just cited, such value is very probably 158·25 meters; from whence we deduce for the length of a terrestrial degree, 110,775 meters. It is an astonishing and scarcely credible fact that this number is as approximate as that which has been given by the exactest operations!

Among moderns, the first who attempted to measure a degree of the meridian was Fernel, physician to Henri II. Leaving Paris, he went toward Amiens, counting the number of revolutions of the wheel of his carriage. He found thus that the length of the degree was 57,070 toises. By a happy accident this result differs little from the truth.

The first measurement meriting the name was performed in 1669 by the astronomer Picard. He established a geodesic system between Paris and Amiens, and operating with much talent and care, obtained 57,060 toises as the length of the degree. This number, multiplied by 90, gives 5,136,300 toises as the distance from the pole to the equator.

I pass over in silence the names of the French Academicians who in 1734 went to measure a degree of the meridian, some to Lapland, and others to Peru. I abstain likewise from mentioning the labors performed at the end of the last century by Mechain and Delambre, in order to arrive at the establishment of a metric system. You know, gentlemen, that very probably the distance from the pole to the equator, measured on the meridian of Paris, is 5,131,180 toises from Peru, and not 5,130,740, as the first calculations made it. This first distance divided by 40,000,000, gives 3*p* 11' 296 as the length of the standard meter.

Now that we know how to manage with regard to our globe, let us carry our investigations to the sun, and let us try to calculate: (1) his distance from the earth; and (2) his radius.

DISTANCE AND RADIUS OF THE SUN.

The sun seems to be endowed with a proper motion which is contrary to the diurnal motion of the heavens, that is to say, from west to east. This retardation of the sun is about one minute of time, corresponding to a little more than 1°. At the end of 365 days and one-quarter (sidereal days), the sun occupies the position in the heavens that he did one year before. This is not all; if we mark, every day, upon a celestial globe the position occupied by the center of the sun at the time of passing the meridian, we find that this point does not leave a plane passing through the center of the globe, and inclined 23·5° on the equator. This plane is the *ecliptic.*

The sun, then, seems to describe in one year a certain curve, a certain *trajectory* situated in the plane of the ecliptic.

In order to determine the nature of such trajectory, we measure every day the *apparent* diameter of the sun, that is to say, the angle formed by two visual rays going to the extremities of a diameter of the disk. This diameter, whose mean value is 32', varies between 31' 31·01" and 32' 35·58". We may easily demonstrate that such variation takes place, very nearly, in a ratio inverse the distance from the sun to the earth.

According to this, let *a b* (Fig. 3) be a circumference representing the ecliptic; let *s*' *s*" be the apparent positions of the sun for each day. If, on the *radius vectors* T*s*, T*s*', T*s*", we make the distance TS, TS', TS" *inversely proportioned* to the corresponding values of the apparent diameter, the curve, A S S'S" . . . B, thus constructed, will represent the sun's *trajectory.* You know that this trajectory is an ellipse, of which the earth, T, occupies a focus. But, what are the true dimensions of this ellipse, or, what is the same thing, what is, in reality, *the distance represented by the radius vector, T S?*

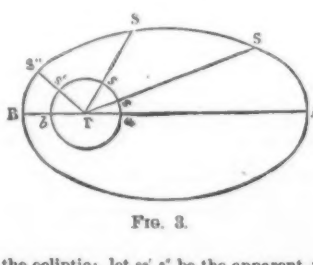


FIG. 3.

In order to solve this problem, astronomers have recourse to the *parallax* of the sun, or, the difference between the zenithal distance, Z A S (Fig. 4), and the angle, Z C S, or, again, *the angle at which an observer, placed at the center of the sun, would see the terrestrial radius,* C A.

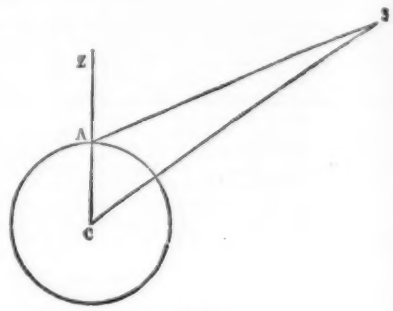


FIG. 4.

A consideration of the triangle, C A S, proves that the parallax reaches its maximum when the sun is at the horizon of the place, A. It then takes the name of *horizontal parallax.* Besides, we find that this latter is nearly given by the formula,

$$P = \frac{r}{d},$$

in which *r* and *d* are respectively the radius, C A, and the distance, C S.

By methods that are very simple, but into the details of which I cannot enter for want of time,* we find that

$$P = 8{\cdot}86'';$$

or, in parts of the radius from trigonometrical tables,

$$P = \frac{1}{23{,}245}.$$

Nevertheless, not to appear as if making an imperfect circle, I will say that

$$P = \frac{Z + Z' - (\lambda - \lambda')}{\sin Z + \sin Z'};$$

Z, Z' being the zenithal distances of the sun in two places situated upon the same meridian, and whose latitudes are λ, λ'. Consequently,

$$d = 23{,}245r.$$

Thus, we have a distance from the sun to the earth equal to about 23,245 times the radius of the latter, or 148,250,000 kilometers. If a movable body, starting from the earth, uniformly passed over 75 kilometers per hour, which is about the greatest speed of locomotives, it would take it more than two hundred years to reach the sun; and yet the light from that luminary reaches us in 8' 13·3".

Again, let T, S (Fig. 5) be the earth and the sun. An inspection of the figure shows that the radii, B S, A T, are very nearly proportional to the angles, S T B, T S A. The first angle is the apparent semi-diameter, and the second is the horizontal parallax. Then, R being the radius of the sun,

$$\frac{R}{r} = \frac{16'}{8{\cdot}86''} = \frac{960}{8{\cdot}86} = 108.$$

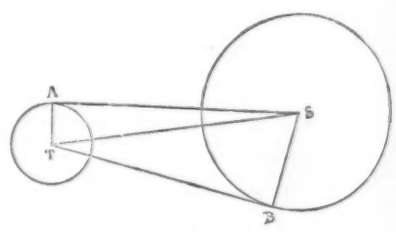


FIG. 5.

Thus the radius of the sun is 108 times that of the earth. Consequently the volumes of these bodies are to each other as 108^3 is to 1, that is to say, the *volume of the sun is about 1,279,000 times greater than that of the earth.* If we proposed to make a relief model representing these two stars, and in which the earth was to be shown by a small ball of a centimeter radius, the sun would be a globe having a diameter of 2·16 meters, placed at a distance of 232 meters from the ball. The following curious comparison is given by the illustrious Arago:

"A professor of Angers, wishing to give his pupils a perceptible idea of the earth's size as compared with that of the sun, struck upon the idea of counting the number of grains of wheat contained in a liter. He found 10,000. Consequently, 14 decaliters contain 1,400,000. Having then gathered into one pile the 14 decaliters of wheat, he took one of the grains and said to his auditors: 'Here is the earth, and there is the sun.'"†

Let us stop a moment at these figures, which ought to make us reflect in showing us of how small consequence we are and how small a place we occupy, not only in the *visible universe,* but even in the *solar system.* Yet the vanity and folly of man are such that for a long time our pitiful planet was made the center of the universe and the end of creation—if there ever was a creation! It has been supposed that the sun, the moon, and the stars were made for man! You might just as well say that elephants were made in order to gladden the sight of ants! So, those philosophers who have desired to substitute science for legend have been poorly rewarded for their glorious attempts. It is said that Anaxagoras came near being put to death because he be-

* Lecture delivered at the University of Liege.

† According to Wollaston, the apparent diameter of Sirius, the most brilliant of the stars, is less than one-fiftieth of a second.

* The most perfect method results from an observation of the passages of Venus over the sun's disk.

† Thirty years ago, the ratio of the volumes of the sun and earth was supposed equal to 1,405,000.

lieved the sun to be larger than the Peloponnesus! You all know the history of Galileo; and you know that that great man, for having taught and propagated the Copernican system, was pursued by the Inquisition and thrown into a dungeon at the age of seventy, and then forced to solemnly abjure, on his knees, the heresy of the earth's motion! In recent times these facts have been disputed, and it has been alleged that Galileo was simply *reduced to silence*. Even were this allegation based on proof, it would not justify the tribunal of Rome. Is it not a horrible means of torture to interdict one from telling the truth? But this is not all: I have read in a pious journal that the Inquisition did rightly toward Galileo, seeing that the sun, instead of being immovable, transports itself toward the constellation of Hercules! I should be sorry to add a word to such a citation, and shall pass on to another subject. Since the sun is the center of our world, and the earth is a planet like the others, have these latter any inhabitants? This is a very natural question, which, for more than two hundred years, philosophers and dreamers (often synonymous terms) have often put to themselves.

After Pierre Borel, Cyrano de Bergerac, Father Kircher, and Gassendi, we must cite particularly the witty and learned Fontenelle. You know that the illustrious secretary of the Academie des Sciences lived to within a month of one hundred years (1657–1757); and that he composed comedies, operas, academic eulogies, gallant letters, a small memoir, an arithmetic, and, finally, the charming work entitled "Conversations on the Plurality of the Worlds," a work ever being reprinted and read.

Fontenelle loved tranquillity, and perhaps too much so. We may reproach him for having said: "Had I a handful of truths, I should take good care not to open it." When a person believes himself to be in possession of the truth, he should make it known in spite of everything.

THE DISTANCES OF THE STARS.

We have seen just now that two visual rays, directed from two observers, A, B, toward a star, *e*, seem to be parallel with each other. In reality, they are not; but the base, A B, (Fig. 6) is too small. In order to render the angle A*e*B

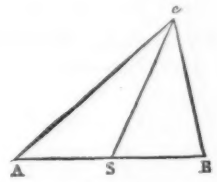


FIG. 6.

appreciable (at least for some stars), we take for base the great axis of the earth's orbit, equal to 46,490 *r*, or 196,000,000 of kilometers. After an interval of six months, we measure the angular distances *e* A S, *e* B S, between a star, *e*, and the sun, S. The complement of the half sum of these angles is very nearly the angle A*e*S, at which an observer, placed on the surface of the star, would see the radius of the terrestrial orbit. The latter angle is the *annual parallax* of the star. The works of Sir William Herschel, J. Herschel, Bessel, Struve, and other astronomers allow us to assert that the *annual parallax of any star whatever is less than* 1"; from whence we conclude (*a* representing the semiaxis of the ecliptic) that

$$d > 206{,}265a.$$

Thus, *the nearest star to the earth is at least* 206,265 *times as far as the sun.*

It would serve no purpose to express in kilometers, or even in terrestrial radii, such a distance. To try to give you an idea of it, let us see how long it would take the light to traverse it. As the light from the sun reaches us in 8' 13·3", the time sought exceeds 8' 13·3" × 206,265=3 years and 82 days.

Here are a few figures additional:

Name of Star.	Parallax	Distance from Earth.	Time taken by light to reach Earth.
of the Centaur..... ...	0·91"	226,400 *a*	3·64 y'rs.
61 of the Swan.....	0·35"	589,300 *a*	9·4 "
α of Lyra.....	0·26"	785,600 *a*	12·5 "
Sirius.....	0·15"	1,373,000 *a*	21 "
Arcturus.....	0·127"	1,624,000 *a*	26 "
The Polar Star.....	0·106"	1,946,000 *a*	31 "
Capricornus (α of Auriga)	0·046"	4,484,000 *a*	72 "

The moving body of which I have spoken as traversing in two hundred years the distance from the earth to the sun, would take nearly *nine million centuries* to go from the sun to the star of Auriga! So gigantic figures as these, however, are mean in comparison with those that it remains for me to say a few words to you about.

THE SIZES AND DISTANCES OF THE NEBULÆ.

The nebulæ are diffuse spots seen in the depths of the heavens, either by the naked eye or by the telescope, and consist of masses of stars; and these worlds are at least as rich as ours. A nebula whose diameter is about 10' (one-sixth of a degree), contains 20,000 stars, while our *firmament*, as it was formerly called, presents only 6,000 that are visible to the naked eye.

The nebula that interests us the most, because, very probably we make part of it, is the whitish and regular luminous zone known under the name of the Milky Way. This zone divides the celestial sphere into two nearly equal portions. It traces therein nearly a great circle, after undergoing a sharp bifurcation from which results the *secondary arc;* and the latter, after being separated from the main arc, over an extent of about 120 degrees, becomes confounded with it again. The width of this zone varies between 5 and 16 degrees. Its two branches embrace more than 22 degrees on the sphere.

The Greeks, who explained everything by fable, said that Juno, having consented to offer her breast to little Hercules, the infant had allowed a little of the divine milk to fall.

The great astronomer Kepler, the philosopher Kant, and the geometer Lambert thought that the Milky Way might well be a nebula, in whose interior we were placed. Guided by that sort of divination, Sir W. Herschel, along about 1780, undertook to *gauge* the Milky Way. This immense work was accomplished in some years. Directing his telescope toward all the parts of the zone that he wished to study, Herschel discovered that they were very unequally rich in stars; in one part the telescope showed *only one* star in a quarter of an hour, while in another it allowed him to detect not only several hundred but as many as 116,000! This is not all; Herschel concluded from his observations that the Milky Way contains at least 50,000,000 stars—50,000,000 suns analogous to our own! "Such numerical results," said Arago, "are truly prodigious." But let us go further.

A very simple geometrical consideration proves that, very probably, the distance from the earth to the limits of the milky nebula, in a given direction, is proportional to the cubic root of the number of stars perceived in that direction. such distance varies, then, at least in the ratio of 1 to 50. Other observations give the ratio of 1 to 100.

En résumé, according to the labors of Herschel, the Milky Way consists of two very thin, nearly parallel layers, having the form of a pair of millstones, extending to incalculable distances, and of which our sun occupies nearly the center. The distances from this star to the limits of the Milky Way vary between 58 and 500 times its distance to α of the Centaur. The light from this star taking about three years to reach us, it requires nearly *three thousand years* for a luminous ray, starting from an extreme limit of our nebula, to arrive at the opposite limit. If we admit, as seems natural enough, that the absolute dimensions of the different nebulæ are not very different from each other, we may ask at what distance from our sun is placed a nebula having a given apparent diameter (10' for example)? In order that an object shall subtend a visual angle of 10", one must be distant from it 334 times its width. If the Milky Way were transported to a distance from the earth equal to 334 times its largest dimensions, its light would reach us only in 334 times 3,000 years, that is to say, in *more than a million years.* These figures, which stagger the imagination, are probably less than the true ones.

Here presents itself quite a dilemma. One of the first verses of Genesis is conceived thus: "And God said, Let there be light, and there was light."

If the gigantic *gas burners* called stars were lighted instantaneously, the being for whom they shone saw them, not at once, but one after the other. Indeed, millions of stars are still invisible up to to-day, because their light *has not yet had enough time* to reach us.

If, on the contrary, Adam, provided with a good telescope, had been able on the day of his birth to contemplate all the stars visible to-day, it would have been because Jehovah had, through thousands and millions of years, successively lighted them!

I do not take upon myself to draw the conclusion, but relegate the question to theologians. You know that they explain everything after the manner of the ancients!

Such, gentlemen, are the objects with which I have desired to entertain you in this friendly lecture. In spite of my inferiority in a subject that does not enter into my habitual studies, the end that I had in view will have been attained if I have been able to interest you, if I have been able to inspire you with a taste for a sublime science, which is at once poetical and philosophical.

COSMICAL BOMBARDMENT OF THE SUN.—THEORY OF COMETARY IMPACT ON THE SOLAR SURFACE.—THE VELOCITY OF COLLISION, AND HEAT EQUIVALENT OF VELOCITY.

By EDGAR L. LARKIN, Observatory, New Windsor, Ill.

AT intervals of considerable regularity the press is burdened with accounts of impending disaster. Some dire astronomical event is always about to occur that will annihilate the human species. And people have been rendered insane by these alarming accounts of threatened ruin.

It is now sought to awaken fear by the formulation of predictions of appalling heat that is to reach the earth, because the great comet that illuminated the circumpolar heavens in 1881 passed peribelion at a point close to the sun. The scheme to destroy mankind is that the comet on its return, in 1897, will suffer sufficient retardation in passing through the gases constituting the corona of the sun to cause it to fall. Inconceivable heat will be generated from the arrested motion, and waves of it will surge against the earth, literally burning humanity alive. All such doctrines are without the slightest grounds in reason or scientific deduction, and the mystery is why any man pretending to astronomical or mathematical acquirements will print such dogmas.

If we raise a mass weighing 772 pounds 1 foot, and then let it fall, the precise amount of power required to raise it will be restored, and will appear in the form of heat, at the instant of impact of the mass on the earth. And, as has been proven, the amount of heat generated is just enough to raise the temperature of 1 pound of water 1° F. But the heat evolved by the fall of 772 pounds 1 foot is equal to that developed by the fall of 1 pound 772 feet. A mass weighing 1 pound that has fallen 772 feet has motion sufficient to conserve heat enough to heat 1 pound of water 1°; or 1 pound of water falling 772 feet generates 1° of heat throughout its mass. This is termed Joule's heat equivalent, and is a valuable element of human knowledge. It is a postulate of recent science that when one mode of force vanishes, another of equal intensity takes its place. Force cannot be increased or diminished; it is one of nature's constants. Motion is a mode of energy, and, invariably, when it terminates, heat—another form of force—appears.

Now, what possibly can be of greater moment than to learn how much motion is required to evolve 1° of heat? We know how great a weight, and how much space; but now comes the question, how rapid must be the motion? The velocity acquired by a falling body at any instant of its fall is equal to the square root of the product of twice the force of gravity and the space fallen through. If a body be let fall, it will be found by delicate instruments to be moving, at the close of 1 second, with a velocity of 32·2078 feet per second. And this velocity is an expression for the force of gravity exerted by the mass of the earth on bodies near its surface. By the rule, 32·2078 multiplied by 2 equals 64·4156, and this multiplied by 772 equals 49,729 feet, whose square root is 223. Of all numbers known to man for purposes of physical research, this 223 is the most important; for we now know that 1 pound of matter moving with velocity of 223 feet per second generates heat enough, when its motion ends, to heat 1 pound of water 1°. That is, this velocity represents 1 pound-degree of heat, or simply 1°, water being unity. With this magic number, all depths of space may be explored, and it can at once be told how much heat will be evolved by the cessation of motion of any cosmical body, as soon as it is learned how fast it is moving.

Having now the heat unit of the universe refined down to definite velocity, we are ready to launch into interstellar space, to learn first the velocities of bodies moving therein, and, secondly, to calculate the intensity of heat capable of being developed if the motion should be brought to a rest. The rule for finding the amount of heat evolved by the termination of motion is: Multiply the square of the velocity in feet per second by the reciprocal of the square of 223, or 0·00002010899.

If a mass of matter fall from an infinite distance, with unimpeded motion, and strike the earth, its velocity at the instant of impact is equal to the square root of the product of twice the intensity of gravity multiplied by the length of the radius of the earth. And this motion at the moment of collision must be found in feet per second, because the unit of measurement is 223 feet per second. Twice the force of gravity is 64·4156, and the mean equatorial radius of the earth is 20,923 161 feet. The square root of the product of these numbers is 36,645 feet, or 6·94034 miles per second velocity acquired by a mass falling on the earth from a distance that is infinite. The force of gravity on the surface of the sun is 27·696 times stronger than on the earth's surface, while the radius of the sun is 108·5113 times greater than that of the earth. Therefore, by the law of gravity, the velocity of impact of cosmic matter on the sun must be 54·8208 times more rapid than on the earth. This is known, because the square root of the product of 27·696 and 108·5113 is 54·8208, whence 36,645 multiplied by 54·8208, gives 2,008,908 feet, or 380·0962 miles per second velocity with which a mass would strike the sun after falling from an infinite distance. And this inconceivable motion must all be converted into heat at the instant of collision. Now square 2,008,908, multiply the product by 0·00002010899, and we have the appalling heat of 81,154,081° F. as the intensity generated by cometary or other cosmic bombardment of the sun by masses that fall from infinite distances. Some sensational writers, having heard of this, at once seek to alarm all timid people by printing outrageous accounts of the impending destruction of man. Such publications are little better than criminal.

What we have said relates to bodies making impact on the sun after reaching it from distances that are infinite; now, how great velocity will be imparted to masses falling from distances that are finite, and capable of being handled by figures? Distance in relation to solar gravity has peculiar properties, thus: the nearest sun to ours is 20,000,000,000,000 miles away; let us go out into space half way, or 10,000,000,000,000 miles, and make computation, seeking to learn with what velocity a mass beginning to fall from that point will finally strike the sun. The velocity, 2,008,908 feet per second, is called the solar constant of velocity, and many complicated problems wherein gravity and motion are factors, can be solved in a few minutes by its use. Employing it in a calculation for a radius of 10,000,000,000,000 miles, and carrying out the work into minute decimals, we shall be surprised to find that the velocity of impact on the sun, by a mass falling that distance, is only one-fourth of an inch less per second than if it came from an infinite distance, or what is the same thing, had been falling for ever! Surprise will wane, however, when it is remembered that gravity varies as distance squared inversely, and at an infinite distance must be infinitely weak, and the motion it can impart infinitely slow. Hence, 10,000,000,000,000 miles has nearly the same relations to solar gravity that infinite space has. Drawing nearer the sun, let us halt at the orbit of Neptune, 2,780,000,000 miles distant, and again apply the formula; when behold, if a mass fall through the distance of Neptune, it will reach the sun with only 155 feet per second less velocity than if it had been falling throughout all duration of time. Still nearer, we come to the orbit of the earth, 92,000,000 miles from the sun's center, and, again computing, find that final velocity of impact on the solar globe of matter from terrestrial distance, would be but 2,411 feet per second less than if it arrived from infinite space. By the use of this important number, 2,008,908, it can at once be told what is the velocity of any cosmical mass at any point in its flight to the sun. Calculating for the earth's distance, it is found that a body passing our world on its way to the sun has a velocity of 26 miles per second, which is the greatest velocity with which anything can strike the earth. Arriving at the orbit of Mercury, and again calculating, we find that a mass beginning to fall from that distance, 36,000,000 miles, will impinge on the sun with a rate of motion only 5 706 feet per second less than if it had been falling for ever. Hence, terminal velocities lie within small limits of variation. Here is a table of velocities in feet per second of bodies making impact on the sun, falling different distances:

From infinite distance, maximum..... .	2,008,908
From Neptune.....	2,008,753
From Mars....	2,007,361
From the earth.....	2,006,497
From Mercury.....	2,008,202
From 436,000 miles, minimum...	1,420,513

It is seen that interstellar matter, whether colliding with the sun from infinite fall, or from Mercury, has 5,706 feet, a trifle over 1 mile per second difference in final velocity, variation being within the limits of 1-380 of the whole. The rate of the motion in the last line of the table is that attained by a mass falling on the sun from a distance equal to the solar radius, 430,000 miles, as we cannot imagine that any cosmic matter will begin to fall from a less distance. Therefore the least velocity of impact is 1,420,513 feet, or 269 miles, per second, and this least motion multiplied by 1·414213 equals 2,008,908 the greatest, hence the maximum and minimum velocities are to each other as 1 is to the square root of 2, or as 1 is to 1·414213.

If we square 1,420,513, and multiply by the reciprocal of the square of Joule's equivalent, as above, we obtain the least heat possible, or 40,577,090° F. What astonishing results are brought to light by these researches. Incredible intensity of heat, the highest being 80,000,000° and the least 40,000,000°! What effect will such outbursts of thermal energy have on the earth? Will the heat vaporize the oceans, parch the land, and consume all organisms? Let us see. First, we must find the relations between velocity, heat, and mass. Take any mass at random, say 52 pounds, and give it any velocity, say 892 feet per second, how intense will be the heat evolved when its motion ends? By analysis, 1 pound moving 223 feet per second has a motion sufficient to generate heat enough to increase the temperature of 1 pound of matter of the density of water 1°; hence if it moves four times as fast, or 892 feet, it has motion able to develop heat 16 times more intense, or 16°, because the square of 4 is 16 times greater than the square of 1, the ratios of their velocities.

If a mass weighing 1 pound, moving 892 feet per second, generates on impact 16°, 52 pounds will evolve 52 times

that amount, or 832°, but the heat will still have the same intensity. By thermometer the mass will indicate only 16° —that is, 52 pounds moving 892 feet per second can generate heat enough to heat 1 pound of water 832 degrees, 832 pounds 1°, or 52 pounds 16°. Now double the mass, by making it 104 pounds, the velocity remaining the same, and we double the quantity of heat and will have 1,664°, still the thermometer reads 16 degrees. The 1,664° being distributed through twice the mass, can have no greater intensity than that conserved from its velocity. Therefore:

1. Increase of mass does not increase the intensity of heat. If we double velocity instead of mass the heat is quadrupled in intensity, thus: 892 multiplied by 2 equals 1,784, and the square of 2 is four times greater than the square of 1; and since heat of impact is proportional in intensity to squares of velocities, we have four times the heat energy, or 3,328° degrees in amount, and four times the intensity, or 64°. This is because four times the heat raises the temperature of 52 pounds 4 times 16°, or 64°, the 3,328° degrees being able to warm 3,328 pounds 1°, 1 pound 3,328°, or 52 pounds 64°. Whence:

2. Heat depends for intensity on velocity, and not on mass. Let 1 pound of matter strike the sun, and whether it fall from an infinite distance or from the distance of any planet its motion will develop on collision, in round numbers, 80,000,000°; let a mass of 2 pounds impinge, and double the amount of heat will appear, but its intensity will be the same, since the final velocity cannot be more than 390·0962, nor less than 379·3943 miles per second. Thence:

3. A comet of great mass colliding with the sun will produce no greater intensity of heat on the sun or earth than one of small mass. Velocities of impact mentioned are those of interstellar masses falling on the sun with unimpeded motion on straight lines. Any comet that can make impact must move around the sun many times before it can collide, its perihelion at each circuit approaching, until finally it is so far retarded by gases in the vicinity of the sun that its orbit comes to almost coincide with the solar surface. Then, if the nucleus is solid, it will ricochet like a canon-ball, and surrender portions of its heat at each impact, nothing like 80,000,000 degrees being developed at any point. When:

4. Maximum heat cannot appear unless cosmic matter fall on right lines to the sun, and not on curves. Heat is now known to be a mode of atomic motion; the greater the rapidity of atomic oscillation the more intense the heat. The reason why a mass on collision evolves heat is because the motion of the whole mass through space is instantly arrested, and massive motion becomes atomic. When the body is moving, each atom in it maintains constant relation to all the others, and no heat is developed. Let the mass strike a solid and each atom begins motion in relation with every other, the instant translation through space ends. If the velocity of impact is great, atomic motion is most rapid, and the heat intense. If the collision is not powerful enough to cause every atom to shift position, all the heat possible will not appear. Let a rifle ball strike a rock, every atom of the lead changes location, the ball is flattened, and, if velocity is sufficient, melted. But if it strike a mass of cork, resistance being so slight, the lead atoms will not shift nor heat appear. Behold the sun; its density is only 1·44, that of water being one, or about the consistency of calcimine applied to our ceilings. A comet would plunge thousands of miles beneath the liquid surface of the sun, and the heat would slowly radiate away, benefiting man instead of destroying him. Therefore:

5. Eighty million degrees of heat cannot develop unless the sun becomes rigid as platinum and cometary nuclei solid. But it is not on these arguments that we rely. We will grant that comets can fall upon the sun, developing maximum heat, allowing alarmists the worst, and then demonstrate that such impact cannot affect the earth in any way except for good. If we burn fifty pounds of coal in one hour it will radiate genial heat, and an iron bar suspended, say, at a distance of four feet from the fire will be warmed through, supposing it to be an inch in thickness. Now, put on a blast and consume the coal in one minute; the bar will not be warmed throughout. Consume the coal in one second, and the surface only of the bar next the fire will be warmed. Burn the coal in the millionth part of a second, the same amount of heat will be given out as when one hour was occupied in the combustion, but the human hand could be held in place of the bar and not feel pain. The heat would be intense, but of such inconceivably short duration that it would not destroy the structure of one's hand. Whence time is a factor in all problems where the action of heat is concerned. Now, let a mass in motion at the rate of one foot per second collide with the sun, and we say the time consumed in impact is such a part of a second; but let it move 2,008,908 feet per second, the time of collision is 2,008,908 times shorter, and the heat that many times more intense, the intensity of the heat depending solely on the time of impact, and the time directly on velocity. Hence:

6. The intensity of 80,000,000 degrees exists less than the 1-2,008,908 part of a second, and the heat wave that can strike the earth will have the same duration. Heat, light, or any other energy emanating from a center varies in the inverse ratio of the square of the distance. The earth is 92,000,000 miles from the sun, but to arrive at results, a ratio must first be deduced. Suppose that above where the comet strikes we place a flat surface at a distance of 100,000 miles, and admit that the radiation of heat hereon from the disintegrated comet would be 80,000,000 degrees. Of course it would not be that intense, for of such intensity is the heat 100,000 miles below; but allow that it would be, then how intense will be the heat reaching the earth? The quotient of 92,000,000 divided by 100,000 is 920, and the square of this number is 846,400. Then, the heat falling on the earth is 846,400 times less than that radiating on a surface 100,000 miles from the scene of collision. Dividing 80,000,000 degrees by 846,400 we find the intensity of a heat wave that can reach the earth from the disruption of any comet large or small on the sun to be 94 degrees. Take a hot day with the thermometer at 94 degrees, double the heat for the 1-2,008,908 part of a second, or indeed for half a minute, and observe the effect on the human species. Really the only way to detect the arrival of the wave would be to turn a large telescope on the sun just before the comet fell, and place in the focus one of Prof. Langley's bolometers capable of measuring the 1-50,000 degree of heat, and look intently on the index with a microscope. Even then it is doubtful if movement of the delicate balance could be seen. We should be pleased to have our telescope set upon the precise point of impact at the time the comet falls to see what would take place. It is scarcely possible that a movement so rapid would make impression on the retina. And high magnifying powers would have to be used, since one second of arc on the solar disk is in linear dimensions 450 miles, and is as small an object as can be seen in a telescope on the sun. But the comet of 1811 had for what was supposed to be a solid nucleus a diameter of 428 miles—less than one second of angular measurement when at the sun's distance; hence the final plunge of a comet into the solar flames could only be seen in good telescopes under favorable circumstances. But a tele-spectroscope of powerful dispersive capacity set on the spot after impact might in the spectrum produced exhibit slight disturbance, such as displacement of the lines caused by outbursts of hydrogen and other gases. Hence:

7. The effect of cometary precipitation on the sun cannot be detected on earth save by the most powerful instruments. What is the sun? It is a colossal ball 860,000 miles in diameter, whose mighty mass is 331,654 times greater than that of the earth. What is a comet falling into this awful furnace? Nothing but as one firebrand in the conflagration of a world. Explosions are always taking place on the sun, causing greater upheaval than the downrush of a dozen comets. Can cometary collision on the sun injure man? Indeed, such impact serves to keep him alive. The sun does not radiate too much heat now, and astronomers are agreed that part of the present supply is kept up by cosmical bombardment. We are flung away in some nook of the universe chained to an expiring world—a home that is already suffering encroachment of polar ice. We exist only by the heat of the sun. The real danger lies not in cometary downrush, but in the fear that not enough meteors and comets will gravitate into solar fires. The longer comets continue to strike the sun, the longer can man inhabit the earth. We thought it the province of science to dispel superstition and fear; and least of all did we think that astronomy would be made use of as an engine of terror. We put in a plea for pure astronomy, and urge that its truths be not tampered with by sensationalists. Interstellar matter perpetually bombards the sun, each collision of meteoric hail sending to earth life-sustaining heat. We trust this cosmic war will not cease, and that at least one comet per week will dash on the sun during the next ten thousand years.

ENTOMOLOGY IN THE CENTRAL PARK MUSEUM OF NATURAL HISTORY.

DESCRIBING recent and expected additions to the Metropolitan Museum at Central Park, the *Evening Post* says that one of the most interesting is the arrangement of cases showing phases of insect architecture and biology. Early in the arrangement of this department, Baron Olsen Saken presented his collection of *Coleoptera*, *Diptera*, etc., which included a very full representation of the insects of North America, exclusive of the butterflies and moths. At the same time he added a series of specimens illustrating insect architecture and biology. The former consists of boughs and foliage whereon are galls and the numerous forms of insect work. Insect life in its several phases is shown in the exhibition of many interesting forms, from the minute egg to the perfect image. To these have been added from time to time other valuable examples. Mr. Fuller contributed specimens of the carpenter bee, its larva and pupa, and a specimen of its characteristic work; also a finely mounted section of the bark of white pine, showing the nest, with pupa and imago of the pine-borer, and another of the locust, with its peculiar pest, *Arhopalus*. In the collection of *Lepidoptera*, presented by the late Coleman T. Robinson, are some beautifully preserved larvæ, retaining their colors and forms quite naturally. These have been gathered into one collection, with their respective imagos. The beautiful specimens added by Dr. Hofman are, in their mounting, in advance of anything hitherto exhibited here. The larvæ of some species are represented by specimens in different stages of growth. In some instances the eggs are preserved; then the worm; after this the pupa and its cocoon; and finally the imago or perfect winged insect. Often the male and female are both shown.

The larger, brilliantly-colored worms, larvæ of the great hawk moths and the like, are very showy; and they retain their colors quite as well as the imagos, though they have been prepared several years.

It is often asked how the worms are prepared so as to retain their shape. An incision is made across the posterior end, so as to include the extremity of the alimentary canal. Then the contents of the worm are pressed out from this opening. A straw is introduced and tied with silken thread, and the worm is kept inflated until dry. It is desirable to give the larvæ its characteristic form, and to do this requires only a judicious manipulation while the object is drying.

In the matter of insect architecture a great field is open to collectors. A glance at the curious forms in the cabinets interests many who have never given thought to the subject before. Among the finer specimens is the nest of the *Rhagium*. On a piece of the bark of white pine, about ten inches in length, is seen on its inner surface a shallow channel, running with the grain, and exhibiting as even and smooth a surface as if planed by an iron tool. This channel extends along nearly the length of the piece, and leads into the circular excavation of the same depth, within which is a circular nest, about two inches in diameter. The latter consists of fine fibers of the wood, as neatly and snugly arranged in circles as the hair material of a sparrow's nest, or, indeed, the more pretentious fabrics of human skill. Several of these were found in the Park. The locust-borer builds quite as securely and wonderfully. The work of the carpenter-bee here exhibited seems like that of some joiner. This insect, the *Xylocopa* (wood-cutter) is credited with a habit of working in decayed wood, on old piles, or posts of gardens, etc., but the present specimen in new stout pine has the look of a piece of joining, as exact and straight in the bore as if done by an auger. The work is done by the strong jaws, or mandibles, and is usually pursued parallel to the fibers of the wood, and extending ten or twelve inches in length. In this work the bee has, like a joiner, left a heap of wood-dust, which she now makes use of to build partitions within. Depositing an egg in the end, or bottom, of the channel, and the requisite amount of honey and pollen, she partitions off the chamber by gluing around its sides the particles of sawdust, thus forming a circular screen. The tunnel is divided in this manner into ten or twelve separate apartments, in each of which a single egg is left. The length of time required to finish the whole may be easily imagined; and we may wonder how the first young bee, which is naturally produced earlier than the others) makes his escape. The unerring instinct of the mother bee has provided a side passage for her first born directly out from its cells, and number one invariably avails himself of this kindly provision. Numbers two to twelve, more or less, are also kindly provided for, and are induced to go to sleep with their heads downward, against the back door, so that on awakening they may lose no time, and not interfere with each other in searching for daylight. The last one hatched has then to traverse all the chambers, passing out, as the rest have done, by the rear door.

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